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Abhandlungen

Three Narratives on the Changing Face of Global Commodities Market Structure

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Abstract

The commodity market structure has changed at an incredible pace in the last 20 years and is now subject to intense scrutiny by academics and policy-makers. Taking a long-term view of price formation, empirical findings show that international trade and finance, mostly driven by emerging markets demand, market liberalisations and technological developments in market infrastructure, have increased pro-cyclicality and interconnection among physical commodity markets. Price formation mechanisms are more sensitive to information flows. The interconnection with the financial system is strong and so the transmission of shocks from the financial system to commodity physical and futures markets. The rise of commodity-linked financial transactions was an important contribution to those developments. WTO commitments in international trade and expansionary monetary policies have promoted greater financial participation and so interconnection, which is also expressed by a greater pooling of commodity returns with returns of financial indexes (also defined here as the true 'financialisation' process). This paper represents an introduction to the functioning and structure of modern commodity markets. Three narratives emerge as key drivers of the modern global market structure: international trade, international finance and trading technology.

Wandel der Marktstruktur globaler Rohstoffmärkte – Drei Erklärungsansätze

Zusammenfassung

Im vergangenen Jahrzehnt ist das Interesse an Rohstoffmärkten rasant angestiegen. Ein langfristiger Überblick über die Preisbildung zeigt einen Anstieg der

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Pro-Zyklizität und wechselseitiger Abhängigkeiten von physischen Rohstoffmärkten. Diese Entwicklungen sind zurückzuführen auf den internationalen Handel und Finanzsysteme, die vor allem durch die Nachfrage der Emerging Marktes und Marktliberalisierung getrieben werden, und den technologischen Fortschritt der Marktinfrastruktur. Der Preisbildungsmechanismus reagiert heute sensibler auf Informationsflüsse. Die gestiegenen, wechselseitigen Abhängigkeiten der Finanzsysteme erhöhen die Verbreitung von Schocks auf physische Märkte und Terminmärkte von Rohstoffen. Die Ziele der WTO für den internationalen Handel und die expansive Geldmarktpolitik der Zentralbanken führen zu einer höheren Beteiligung der Finanzmärkte, welche sich im Gleichlauf von Rohstoffrenditen und Renditen von Finanzindizes erkennen lässt (und als „financialisation" bezeichnet wird). Dieser Beitrag liefert eine Einführung in die Strukturen und Funktionsweisen von modernen Rohstoffmärkten. Dabei sind drei bedeutsame Erklärungsansätze für die neue Marktstruktur zu nennen: der internationaler Handel, das internationalen Finanzsystem und die Geldmarktpolitik, und zudem auch der technologische Fortschritt

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JEL Classification: Q02, F61, F62, E52

I. Setting the Scene

A 'commodity' is a good with standard quality, verifiable ex ante, which can be traded on competitive and liquid global physical markets (Clark et al. (2001)). As Table 1 suggests, commodities are search goods for which information on quality can be easily assessed before the purchase, with no need to experience the product (as it would be the case for experience goods such as 'durables'). This implies that demand for goods with similar supply and product characteristics will be intrinsically 'less sticky' to price changes (i.e. high price elasticity) for search goods (commodities) rather than experience goods. These characteristics allow parties to 'shop around' more easily, especially for commodities with more standard quality (e.g. corn). Low costs to acquire information about product characteristics and other structural factors make these goods suitable for trade.

Each commodity has its own specific characteristics, such as product properties, availability in nature, transportability, production and storage processes, substitutability, concentration of producers/users, nature of the value chain, and so on. In addition, some commodities, such as agricultural commodities like wheat and corn, are renewable and therefore have seasonal price swings, mainly due to structural supply constraints. For instance, wheat can only be harvested once a year (from May for winter wheat to mid-August for spring wheat). Cocoa plants, in contrast, be-

Table 1

Key Characteristics

Types of goods	Products	Quality assessment		Use	Information costs
		Ex ante	Ex post		
Search	Commodities (e.g. crude oil or rice)	Yes	Yes	Intermediate	Low
				Final	
Experience	Durable goods (e.g. car)	No	Yes	Intermediate	Medium
				Final	
Credence	Financial services (e.g. loan or investment advice)	No	No	Intermediate	High
				Final	

come commercially productive roughly five years after plantation and their economic life can last up to 40 years. Supply characteristics may therefore affect demand elasticity when, for instance, availability of substitute products is limited, as in the case of crude oil. Product characteristics, such as the ability to store the product over a long period, are also key elements. Notably, alternative uses, such as the production of ethanol from corn crops, and excessive dependence in the production process from energy costs, as in the smelting of alumina, allow commodities prices to influence each other's price formation processes (again, as in the case of crude oil).

1. *A Complex Marketplace*

Price formation in markets for physical commodities and futures contracts is the result of complex interactions between idiosyncratic factors, such as product characteristics (quality, storability or substitutability, etc.) and supply and demand factors (capital intensity, industry concentration, production facilities, average personal income level or technological developments, etc.), and exogenous factors, such as access to finance, public subsidies and interventions, and the weather.

The product characteristics of the commodity itself also affect how these sets of factors impact price formation. In general, supply factors (such as capital intensity) are more important drivers of price formation

Table 2

Key Drivers of Commodities Price Formation

Product Characteristics	Supply Factors
• Quality • Storability • Renewability • Recyclability • Substitutability • (Final) usability	• Production convertibility and capital intensity • Horizontal and vertical integration • Storability and transportability • Industry concentration • Geographical concentration (emerging markets) • Technological developments • Supply peaks and future trends
Demand Factors	**Exogenous Factors**
• Income growth and urbanisation • Technological developments and alternative uses • Long-term habits and demographics • Economic cycle	• 'Financialisation process' and monetary policies • Subsidies programmes • General government interventions (e.g. export bans) • The economic cycle and other macro-economic events • Technological developments • Unpredictable events (e.g. weather)
Market Organisation	
• Micro-structural developments (e.g. competitive setting) • Functioning of internationally recognised benchmark futures or physical prices • International trade • Futures markets infrastructure	

for energy commodities and industrial metals, while agricultural and soft commodities markets are more influenced by demand factors (such as income growth) and exogenous factors that can cause supply shocks (such as weather events or government policies). Energy commodities and industrial metals rely on a more complex market organisation with easier access to finance due to their ability to hold value (for carry trades), which may enhance pro-cyclicality with regards to shocks within the financial system (opportunity costs).

a) Physical and Futures Markets

The standard quality of the good makes commodities easy to sell to end users, whether consumers or industrial companies. With technological advances and trade globalisation, in recent years, small regional markets have gradually become international or global market hubs, accessible directly through physical operations run by global freight companies and trading houses, or indirectly from any place in the world through the 'pit' (floor) or the electronic access to a venue running trading of physically deliverable (or offset) futures contracts globally. The creation of liquid and competitive international markets has reduced transaction costs and increased chances to meet individuals' risk profiles. This section explores the general characteristics of commodities markets and their role in coping with commercial firms' and individuals' choice.

There are two types of commodities markets: physical and futures (derivatives) markets. The physical market is a general market (hard to point to one specific place where the trade is done) that accommodates the need to balance supply/demand disequilibria. Futures markets serve the intertemporal choice of end users by trading expectations on supply and demand patterns, which occur mainly through changes of inventory levels over a diverse time period. Futures contracts are usually negotiated on open and transparent platforms. Particular characteristics, such as seasonal production or demand, require the use of tools that can ensure sufficient time to plan business development and investments in production processes.

To accommodate demand and supply, these markets should be competitive and liquid (Clark et al. (2001)), which means that they will be able to provide a market clearing price at all times, and for all quantities, within a reasonable time frame. The availability of market clearing prices for all orders sent by the buyer/seller implies a dynamic equilibrium between demand and supply. A competitive market structure would potentially increase efficiency and market liquidity over time. It is important that barriers to entry to and exit from the market are always kept fairly low, and competition authorities are able to enforce competition rules and fight monopolistic market behaviours. Particularly in commodities markets, structural supply or demand constraints may favour conditions for the development of monopolistic, oligopolistic or monopsonistic powers and, thus, for one or more counterparties to charge unfair markups on final prices. Since commodities markets are central to the global economy, the efficiency of their market structure should be seen as a crucial area of coordination among national supervisory bodies.

aa) The Fundamental Role of Inventories

Inventories are the first real barrier against market prices fluctuations. Inventories minimise the costs of adjusting production due to foreseeable (e.g. demand volatility or increases in the marginal cost of production) and unforeseeable (e.g. weather shocks) market circumstances. Inventory levels keep demand and supply in equilibrium over time. In addition, they reduce marketing costs by facilitating production and delivery schedules (Pyndick (1994), (2001)). Inventories also reduce the impact of unpredictable disruptive events, working as a buffer against exogenous factors. As a consequence, the main drivers of inventory levels may vary depending on the type of commodity. For metal (and perhaps energy) commodities, inventory levels are primarily affected by the business cycle, mainly through Gross Domestic Product (GDP) levels (Fama/French (1988)). When a peak in demand comes, inventory levels go down drastically to absorb the adjustment of production, and vice versa. For seasonal commodities such as food and agricultural commodities, however, weather changes may have important effects on inventory levels by affecting the productivity of the harvest season. In both cases, changes in the inventory levels have immediate effects on spot and futures prices, which react differently to the high or low level of inventories (Fama/French (1988)). Inventories are the response function of net demand levels.

Furthermore, inventories need to be properly managed because they have explicit and implicit costs of storage that will ultimately affect production costs. If released too quickly into the market, inventories can cause excessive supply and a drop in spot and futures prices. Management of inventories is a key risk management process for commodities firms.

Carrying a commodity (storage) over time has three main costs:

- Costs of physical storage (and insurance).
- Opportunity costs.
- Costs from price risk.

Storage costs can be split into three subcategories: warehousing and handling costs (load in, load out, storage), insurance, and material degradation. Costs of storage essentially depend on the availability of warehouses, competition for them (if not owned by the commodity owner), and the nature of the commodity, which may need specific storage characteristics to limit material degradation. The storability of the commodity may be fairly limited – green coffee beans can only be stored for few months before losing their original properties, for instance.

Another important cost of storage is the opportunity cost of carrying a commodity over time, which includes the interest foregone by not investing the capital in risk-free instruments instead of in the commodity. The central bank's nominal interest rate is usually considered as point of reference to calculate foregone interest. Current and future rates of consumption, as well as price volatility, are elements that contribute to the cost of carry, but they may not be easily predicted.

Finally, there is a potential cost (or benefit) if prices move against the commodity holder, in particular if the future spot price will be below expectations. In effect, expectations about spot prices are part of the storage costs internalised through futures prices. This cost can usually be efficiently hedged in the derivatives markets.

b) Interaction Between Futures and Physical Markets

The price interaction between futures and physical[1] markets happens in two phases: during the duration of the futures contract, and at maturity. During the duration of the futures contract, information about inventory levels and exogenous factors fuel increasing or decreasing divergence of futures prices with spot prices. When the futures price is above the spot price, i.e. the basis (difference between spot and futures price) is negative, the market is in 'contango'. When the futures contract price is below the spot price (i.e. the basis is positive), the market is in 'backwardation'.

At maturity, the price of the futures should converge to the spot price due to the 'commitment to deliver' mentioned above, which does not allow arbitrage to become systematic. As inventories fall, the spot price gradually catches up with the futures price and the curve inverts into backwardation until, for one of the three reasons mentioned above, the inventory levels recover and futures prices begin to regain ground to converge at maturity.

[1] The words 'physical' and 'spot' are used interchangeably in this paper. 'Spot price' can be pure physical trade or rolling front month futures price.

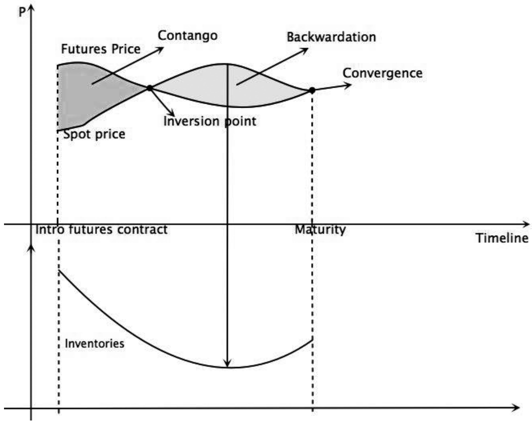


Figure 1: Futures-Spot Price Interaction Through Inventories

For storable commodities, as a consequence of the storage theory (i.e. the storage process, being a response function of supply and demand, drives futures and spot prices), when the futures curve is in contango a 'cash and carry' trade opportunity arises. More specifically, the commodity investor will have incentives to sell the forward contract and buy the commodity directly or through a loan, if the risk-free interest rate is sufficiently low. When the futures curve is in backwardation, though, the futures price is insufficient to cover cost of storage and interest foregone for alternative investments, so the commodities investor may enter in a 'reverse cash and carry' trade. He/she buys a future contract and sells the commodity immediately.

aa) Price Convergence

An important factor in the interaction among futures and spot markets is the convergence of futures prices to the spot price. This is mainly due to the 'commitment to deliver' embedded in the futures contract, which ensures that futures markets are always linked to underlying physical markets. Close to delivery (maturity), markets start to discount that, if the futures price diverges at delivery, there is an opportunity of arbitrage among markets and so the market will adjust its value to the spot market. For instance, if at the delivery date the futures price is lower than the spot price, the market will buy the futures contract until the two prices become equal (taking into account costs of delivery and differences due to different grades, etc.). Anticipating this behaviour, futures prices (front-month and other contracts with same maturity) will then adjust automatically to the spot price close to maturity (plus a differential). The 'commitment to deliver' also ensures that futures market dynamics do not affect the spot market price directly. If prices do not catch up, arbitrage will produce convergence anyway.

However, in practice, futures and spot prices may in any case have some difference at maturity, as the futures prices embed delivery and interest foregone before you can actually hold the commodity. Futures/spot price divergence can be determined by two sets of factors:

a) The underlying commodity and delivery.

b) Problems with physical settlement.

First, there is divergence if the physical underlying asset to be hedged is different from the commodity underlying the futures contract (e.g. using a crude oil futures contract to hedge jet fuel costs), as well as delivery features of the contract that are embedded in the final price (free-on-board, or f.o.b., in-store, etc.). Second, divergence can be caused by any impediment that does not allow delivery of the physical commodity. These impediments can arise because of problems with the grade of the commodity (and its chemical attributes), or the location of the delivery. A prolonged delay in delivering the commodity may cause a spike in order cancellations and a sudden increase in price of physical and futures because the supply of the commodity is constrained.

The evolution of global commodities market structure had a fundamental impact on the quality of price formation, both in terms of ability of futures and physical prices to convergence, and the liquidity of underlying physical commodities markets and their interaction.

II. Three Narratives of Key Commodities Market Structure Developments

While commodities prices follow short or medium term cycles, the market structure of physical and futures markets evolves over a longer time period and with more long-lasting effects. This paper focuses on the three key elements of the structure of a market: demand and supply (the impact of the international trade), access to funding (the role of international finance), market infrastructure (for trading of physical commodities and paper). The following sections explore these items individually and offer some empirical findings to assess the effects on the evolution of commodities market structure. In its assessment across different commodities markets, this paper only considers storable commodities, as they offer dynamics that are closer to the theoretical framework discussed in the first section. The empirical analysis gathers evidence in the following commodities markets: crude oil, natural gas, iron ore, aluminium, copper, corn, wheat, soybean oil, sugar, coffee and cocoa.

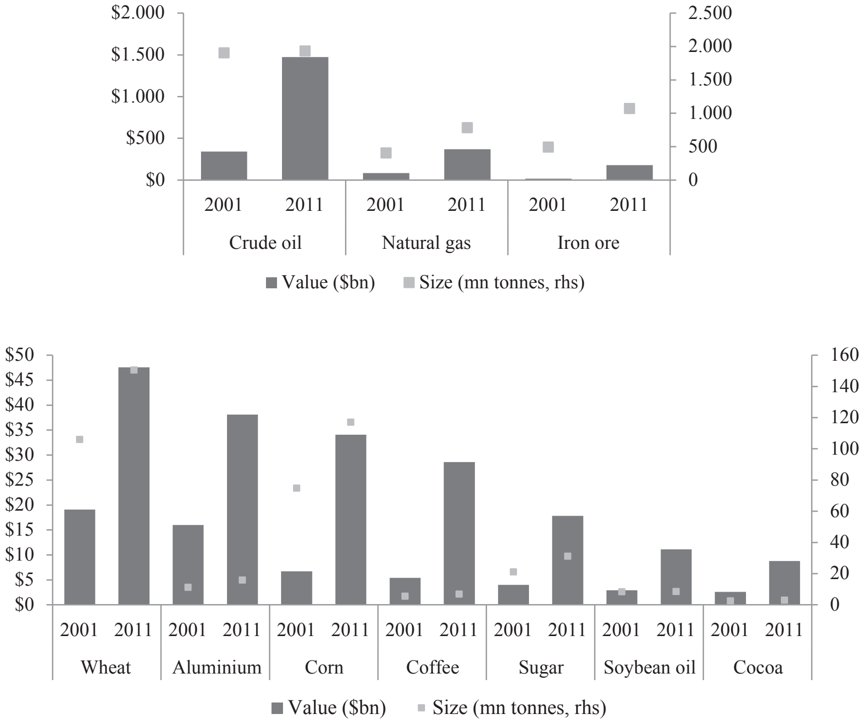
1. A Story of International Trade

The last two decades will be remembered as the era of flourishing cross-border trade in commodities and increasing interconnection among diverse regions and physical markets around the world. The globalisation of trade across all commodities markets has been strongly supported by trade liberalisations at regional level and international commitments of key global players under the World Trade Organisation (WTO) umbrella. The process of greater economic integration, begun during the 1980s, has been self-reinforced by the economic expansion of emerging markets, such as China, India and Brazil, emerging most importantly as key consumers of commodities (such as fossil fuels). Their growing participation in global commodities markets boosted exports both in value and size. Markets have seen an unprecedented demand from countries that were not even captured by general statistics about commodities trade two or three decades ago.

As suggested by Figure 2, the growth rate between 2001 and 2011 has been remarkable. The compounded annual growth rate of exports value for selected commodities has been on average above 15 %, even if the size of global exports for some has remained more or less stable over the years for commodities like crude oil.

The growth of international trade has been sustained and has been self-reinforcing the constant growth of commodities prices in the last decade, after several years of historically low prices. If we look at long-term real prices for selected commodities in this paper,[2] a general growth of spot prices occurred, with many commodities showing an annual average of the real price above historical peaks (see Figure 3).

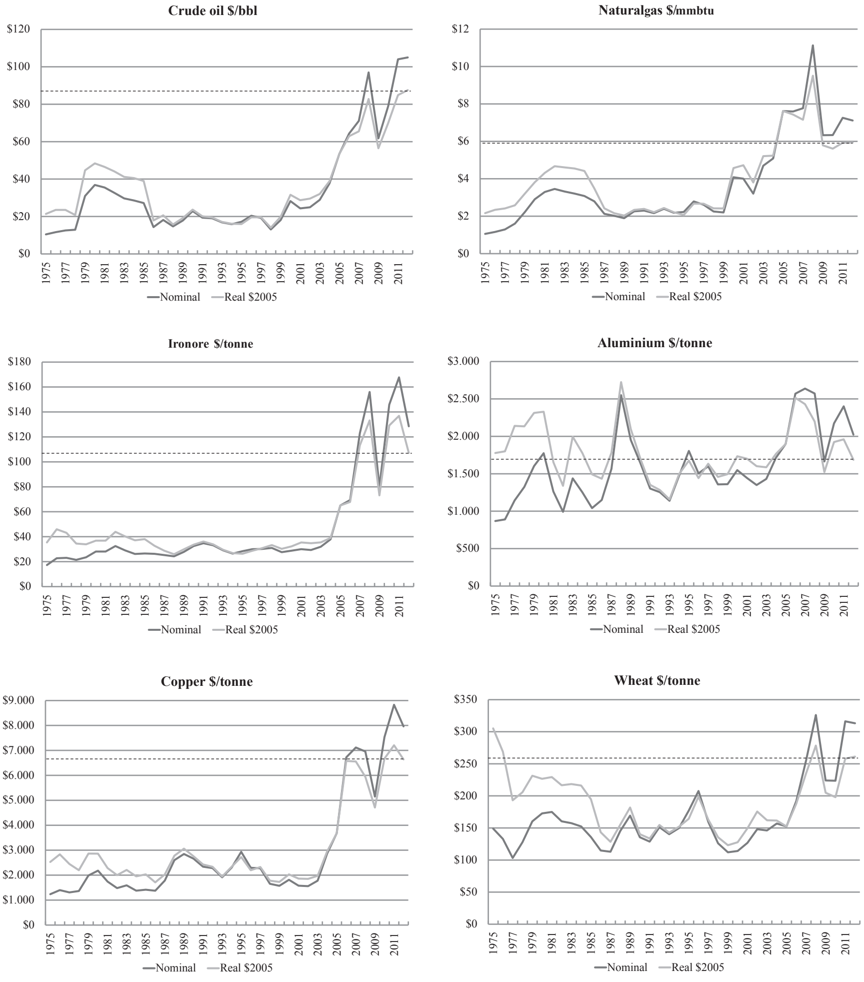
[2] In particular, crude oil, natural gas, iron ore, aluminium, copper, wheat, corn, soybean oil, sugar, cocoa, coffee.



Source: Author from World Bank, USDA, ABREE, BP, OPEC, FAO. Note: *Data on exports for aluminium are estimates.

Figure 2: Value and Size of Global Exports 2001–2011

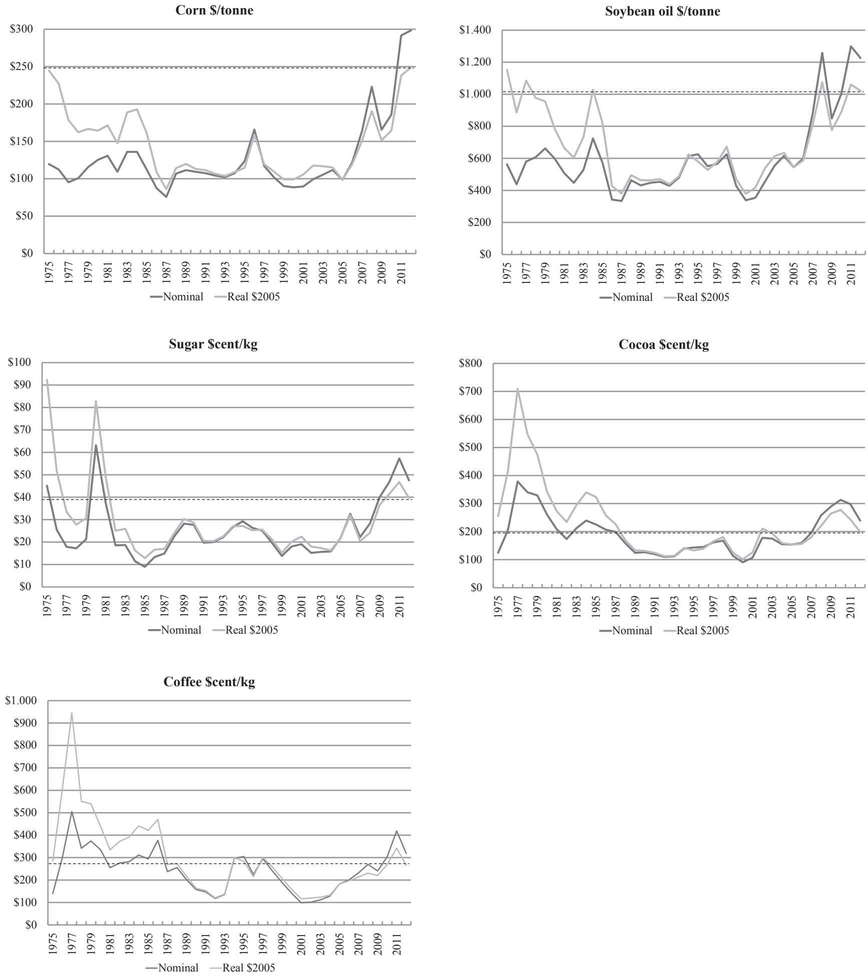
Spikes over the last century, both in price and volatility levels, have followed a long period, ended around 2005, of price patterns at historical bottoms for long time. The development of international trade in commodities has given an important contribution to this shift in prices, in particular the growth of emerging markets demand supported by the building up of scale in the international freight industry.



Source: Author's elaboration from World Bank. Note: World Bank Manufactures Unit Value Index deflator (representing 15 commodities countries with ad hoc weights, with base year = 2005). Dashed line compares 2012 real price with historical trend.[3]

Figure 3: Long-Term Nominal and Real Spot Prices for Sample Commodities, 1975–2012

3 For crude oil, average spot price of Brent, Dubai and West Texas Intermediate, equally weighted; for natural gas, average between natural gas (Europe) import border price, including UK (as of April 2010 includes a spot price component; between June 2000 – March 2010 excludes UK), and natural gas (U.S.), spot price at Henry Hub, Louisiana; for iron ore (Brazil), VALE (formerly CVRD) Carajas sinter feed, contract price, f.o.b. Ponta da Madeira 1 % Fe-unit for mt, prior to year 2010 annual contract prices; for aluminium and copper, LME cash forwards; for wheat,



no. 1, hard red winter, ordinary protein, export price delivered at the US Gulf port for prompt or 30 days shipment; for corn, no. 2, yellow, f.o.b. US Gulf ports; for soybean oil, crude, f.o.b. ex-mill Netherlands; for sugar, International Sugar Agreement (ISA) daily price, raw, f.o.b. and stowed at greater Caribbean ports; for cocoa, International Cocoa Organization daily price, average of the first three positions on the terminal markets of New York and London, nearest three future trading months; for coffee, equally weighted average between International Coffee Organization indicator prices, other mild Arabicas, average New York and Bremen/Hamburg markets, ex-dock, and Robustas, average New York and Le Havre/Marseilles markets, ex-dock.

a) Emerging Markets as the Game Changer: the Growth of Chinese Demand

China's entry in the WTO is perhaps the most important event for international trade in the last two decades. After a 15-year process, China was admitted to the WTO on 11th November 2001, after requesting to resume talks as contracting party of the General Agreement on Tariffs and Trade (GATT) in 1986 and after requesting to enter the WTO in 1995, when the institution was established. Commitments to remove tariffs and other restrictions, already started before the accession, were mostly met by the end of 2004 when China became a fully-fledged global trade partner in the WTO. The opening up of its economy began back in 1979 (Rumbaugh/Blancher (2004)) and had since gathered pace. Entry in the WTO has led China to reconsider, among other commitments, the following (WTO (2001)):

- Discriminatory practices between Chinese and non-Chinese WTO members.
- Dual-pricing practices for domestic and export products.
- Price controls to protect domestic firms.
- Updates to current regulatory framework to reach international standards.
- Full right to export and import in the country.
- Export subsidies for agricultural product.

Despite some exemptions from these commitments (cereals, tobacco and minerals, among others), the deadline for the implementation of these commitments was three years from accession (December 2004). Since 2001, China had been easing many of these restrictions, even though there were several areas where further improvements were needed. Agricultural policies, renewable energy technologies, electronic payments and insurance regulation are some of the key areas (USCBC (2010)).

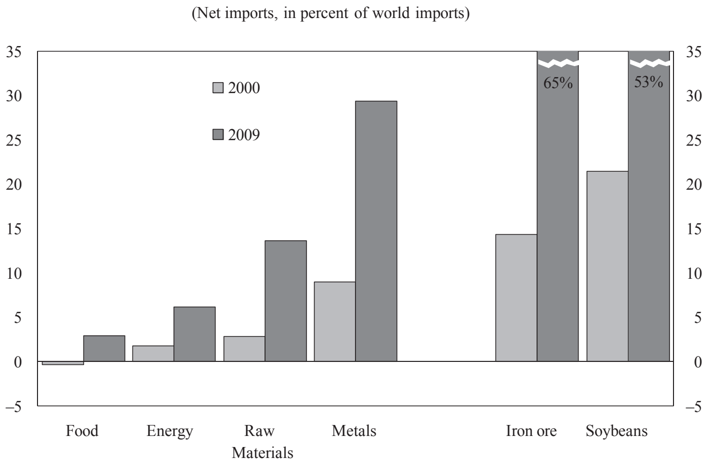
China has become by 2011 the third largest global exporter and is very close to overtaking the United States (Table 3). Despite losing ground, the European Union still remains ahead of China as global trade partner.

The gigantic growth of China is also clearly reflected in net imports. In particular, the explosion is visible for net imports in raw materials and metals, reaching around 14 % and 30 % of global imports, respectively.

Table 3

Top Global Exporters and China (% of Total Exports)
(Author's elaboration from World Bank)

	2001	2003	2011
European Union	40.1 %	42.0 %	35.1 %
United States	13.1 %	10.9 %	9.6 %
Japan	5.8 %	5.6 %	4.2 % (4th)
China	3.9 % (5th)	5.2 % (4th)	9.5 % (3rd)

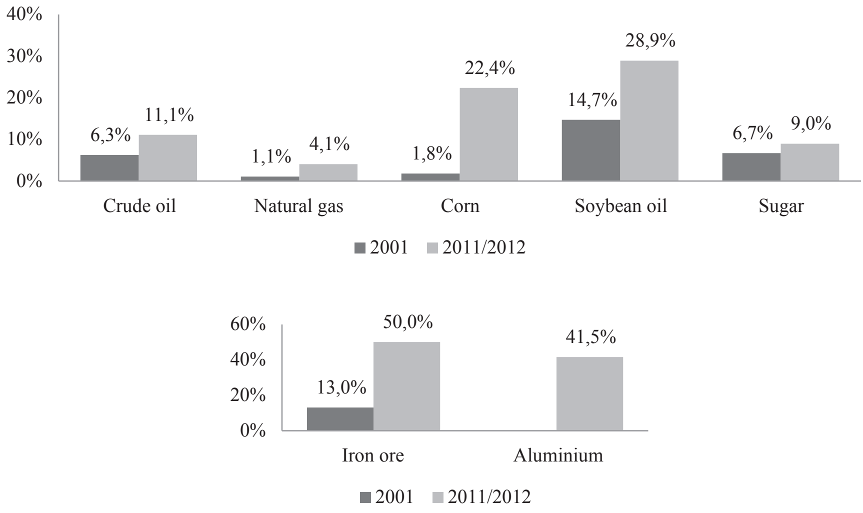


Source: IMF (2011, p. 4).

Figure 4: Chinese Net Imports (% of World Imports)

Active global trade accounts are also reflected in consumption levels, with China becoming the top global consumer of iron ore, aluminium, copper, and soybean oil in 2011. It is among the top three global consumers for crude oil (2nd), wheat (2nd), corn (2nd), sugar (3rd), and natural gas (4th). No major levels of consumption emerge for cocoa and coffee, but the Chinese weight is constantly growing over time in these markets too.

For agricultural commodities, such as wheat and corn, not much has changed in the last decade in terms of consumption levels, as the population is gradually stagnating and alternative use of biofuels production is still in early development. However, China has become the top global



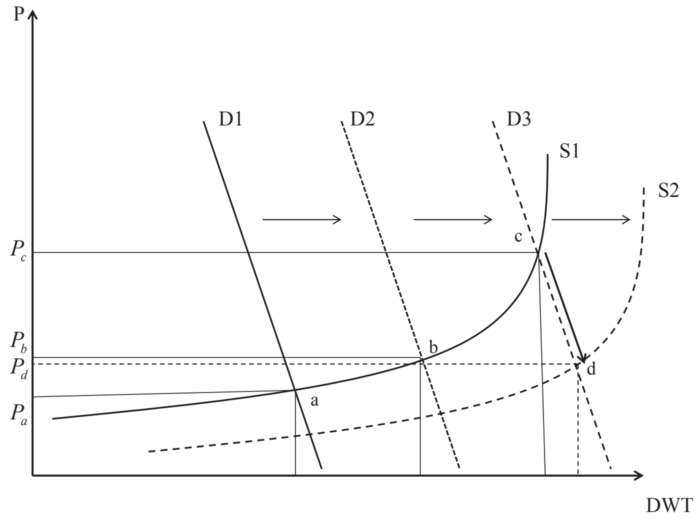
Source: Author's calculation from IMF Database, BP, OPEC, ICSG, USDA and other governmental authorities.

Figure 5: Chinese Consumption as % of Global Consumption 2001–2011/2012

commodities consumer. Over time, it is unquestionable that China will need to make more efficient use of current resources. If the country does not increase its greater independence from external provision of low-cost resources, the energy-intensive nature of its manufacturing economy and its ageing population will put additional unstable pressure on commodities prices. The more China grows in size, the more its weight on commodities markets may become unsustainable (at least in the short term) if competing global players do not reduce consumption levels. This situation might be seen as an incentive to finally increase efficiency in the use of global resources, but it will take years before relevant changes may see the light.

b) Freight Markets: the Backbone of International Trade

Seaborne freight markets are the backbone of international trade, but the structure of freight markets presents many challenges, which has contributed as well to higher price volatility in recent years. Inelastic demand and supply exposes the market to sudden price swings and prolonged periods of instability. Figure 6 describes supply and demand interaction. As demand for seaborne freight services grows, the curve grad-



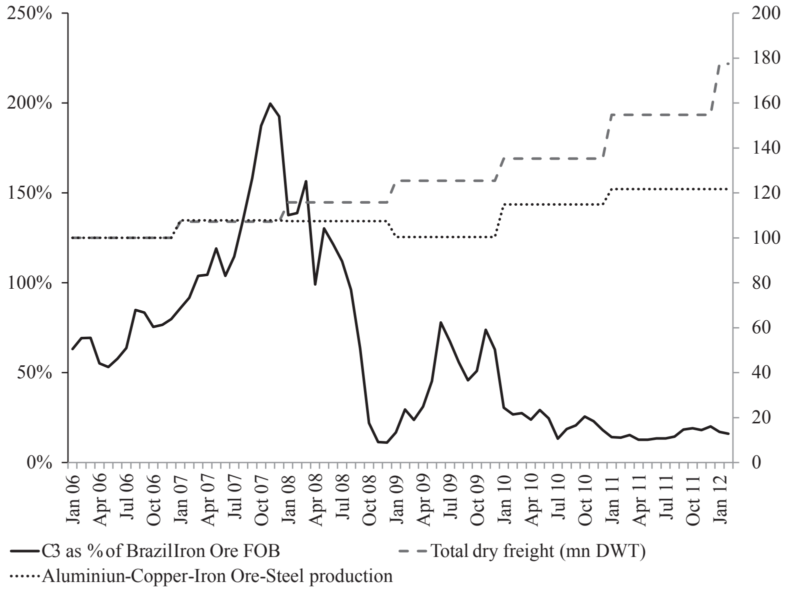
Source: Adapted from *Nomikos* (2012).

Figure 6: Supply and Demand Interaction

ually shifts to the right from point a to point b, i.e. more demand causes the equilibrium to move to a level with higher quantity to be supplied at a higher market-clearing price. The growth in demand for minerals and industrial metals for construction in emerging markets from 2001 to 2007 contributed to the gradual shift from point a to point c. Among the industrial metals, iron ore production went up 82.63 %, aluminium by 56.27 % and crude steel by 63.27 %. Total global production of iron ore, steel, aluminium and copper soared by 72.8 %, on average.

Eight years of steady growth in demand gradually raised prices and volatility to unsustainable levels, once the capacity of the system had reached the critical point c. Freight rates for Brazilian iron ore, for instance, reached up to 200 % of the value of the underlying commodity in the autumn of 2007 (Figure 7), to fall below 20 % of the commodity price in under six months.

As a consequence of this prolonged instability, investments from financial firms flowed into the industry to build sufficient capacity and keep up with growing volumes, shifting the supply curve (Figure 6) to the right (S2), i.e. the supply capacity experienced a sudden increase that pushed prices down over a short time frame. As a result of the growing supply of dry bulk cargoes (+33.62 %) and the drop in demand in 2008, following



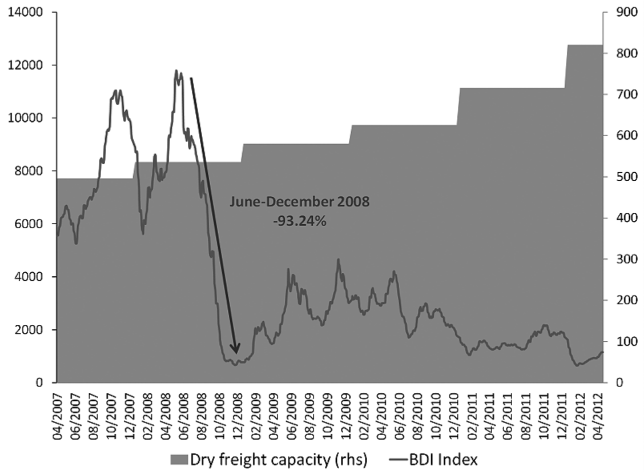
Sources: Author's elaboration from ICAP, UNCTADstat, WBMS, World Steel Association (WSA), LKAB.[4]

Figure 7: Freight Rates and Total Production/Capacity (2006 = 100)

the anaemic growth of global production due to the global financial crisis initially triggered by the burst of the housing market bubble in western economies, the cost of shipping tumbled by over 93 % between June and December 2008 alone (Figure 8). Prices dropped to the equilibrium point d and may stay there for some time.

Since December 2008, prices have been subject to significant swings but have never returned to the levels reached in 2008. To hedge against these highly volatile trends and exogenous factors, such as port congestion or geopolitical events, market participants are increasingly using forward contracts on underlying shipping routes, which are linked to indexes such as the BDI. These contracts are cash-settled, and over-the-counter (OTC) traded and cleared. They tend to have a high basis risk, i.e. the difference between the price of the forward and the underlying exposure, as they track an index and not the specific characteristics of the exposure. Liquidity in this market is usually concentrated in one-month to two-month contracts (Geman (2005)).

[4] C3 freight rate is a dry bulk rate to ship iron ore from Brazil to China.



Sources: Author's elaboration from ICAP and UNCTADstats.[5]

Figure 8: BDI Index and Dry Freight Capacity (mn Dead Weight Tonnes, DWT)

c) Moving Competition on Production Costs and the Role of Subsidies

Another key fall-out of more international trade is the continuous focus of competition on production costs. Competition on production costs from new regional areas has made subsidies programmes much more expensive, contributing to a more efficient price formation coupled with higher volatility as prices begin to reflect the true underlying supply and demand factors. In some areas, such as agricultural commodities, government subsidy programmes have supported artificial prices and reduced incentives to invest in new more efficient technologies to reduce energy consumption in metal production or harvested areas for crops, for example. When subsidies have gradually become less distortive, prices have begun to discount the lack of investments in infrastructure, which puts a big constraint on the ability of supply to meet demand with the potential creation of substantial regional imbalances.

More generally, growing links between commodities markets and international trade have intensified the effects of government actions such as export bans. Most notably, direct market price intervention in an open

[5] The Baltic Dry Index (BDI) represents a major dry freight cost index that collects rates on major global routes, widely used across the shipping industry.

market model with international trade is unable to create incentives to tackle underlying problems of market structure. When the fiscal capacity of a country is reduced, the market has to face sudden adjustments in the flows of commodities (e.g. oversupply) with highly volatile patterns, especially for agricultural commodities for which the opportunities costs of the land are generally higher in relation to other commodities markets. For instance, in agricultural and soft commodities markets, where the opportunity costs of the land use are high (e.g. US wheat farms) or too low (e.g. sugar plantations in Brazil), public investments in new technologies for innovative applications and infrastructures, respectively, might be a preferable alternative to subsidies. They might favour more efficient allocation of the land if the market itself is unable to rebalance due to such transaction costs.

2. *A Story of International Finance*

Over the last decade, commodities markets have increasingly improved their access to international finance. Due to accommodating monetary policies and financial deregulation, the high returns generated by growing international trade fuelled by demand emanating from emerging industrial economies have attracted the interest of financial institutions hoarding cash for what has been commonly perceived as an anti-cyclical asset class. Financial leverage appeared therefore instrumental to the development of international trade. More interaction with the financial system also means easier access to financial leverage by commodities firms, and in particular by trading companies.

More specifically, greater accessibility to finance was led by the following developments:

- Deregulation;
- New theoretical framework in investment portfolio theories; and
- Expansionary monetary and fiscal policies.

Regulatory changes throughout the 1990s in the United States culminated in 1999 with the US Gramm-Leach-Bliley Act (GLBA) or the Financial Services Modernization Act[6], which repealed part of the Glass-Steagall Act (1933)[7] and the separation between investment and com-

[6] Pub.L. 106–102, 113 Stat. 1338, enacted November 12, 1999.

[7] Within the Banking Act, Pub.L. 73–66, 48 Stat. 162, enacted June 16, 1933.

mercial banking. The GLBA, in particular, allowed combinations of different financial activities (commercial, investment and insurance), through the use of subsidiaries, within the same group. Secondly, early evidence of a supposedly counter-cyclical nature of commodities markets and their role for diversification strategies (Gorton/Rouwenhorst (2004), among others) has attracted liquidity from non-commercial passive long investors, which have contributed to the liquidity of futures markets. Finally, next sections will explore the role of expansionary monetary and fiscal policies to push new investments into commodities markets.

a) The Entry of New Market Players

The last decade has seen the massive entry of new financial players and the expansion of financial intermediation. Low costs of financing and lower opportunity costs (returns on alternative asset classes) have favoured storage of commodities (carry trades), especially those with a good 'store of value' properties such as metals. These circumstances have increased the opportunities for financial participants to enter these markets and the opportunities for commodity trading houses to use financial leverage to expand their physical interests.

Firstly, an exponential growth of financial intermediation occurred, with top financial institutions at the end of 2011 holding over $5 trillion in commodities derivatives (notional), with the whole exchange-traded derivatives markets estimated around $3.5 trillion (notional).[8] The business of financial institutions has developed in different directions in the last decade. The range of financial institutions is very broad and includes: brokers/dealers, private banks, commercial banks, merchant banks, insurance companies, investment managers, mutual funds, hedge funds, and private equity funds. While the direct holding of physical assets is limited to some of them, several financial institutions are involved in financing and providing trading desk services for commodities firms. To develop these activities and make them more profitable, some of these institutions have invested significant resources in physical assets, such as supply and production firms, warehouses, and logistics/transportation companies. The growing importance of finance for funding large and medium commodities businesses has led to diversification in the business model of investment banks, which have increased their investments in

[8] For more data on financial institutions derivatives exposures and the size of exchange-traded derivatives, see annex.

physical commodities trading. The growth of commodities firms and their global impact has led production and risk management functions to become more interconnected. This has become a profitable business for financial institutions, as commodities firms are not always able to handle all exposures through their own internal risk management systems. There are also myriad smaller banks that provide financing services to the commodities business, on top of other financing and investment services provided in other forms than derivatives transactions.

Secondly, there is a handful of global commodity trading companies that combine the offer of intermediary services for other commodity firms (in physical and financial services) and logistics in multiple commodities (typically oil, some metals and a few agricultural commodities). These firms, also due to the easy access to international finance through their strong trading arms, have also increased their exposure to physical markets over the years through the ownership of firms dedicated to production, refining, and/or logistics. The nature of trading companies, which typically invest in the most profitable areas of commodities markets through sophisticated financial instruments and financial leverage, makes their offers more diversified across commodities markets, but also exposes them to fluctuations in futures markets and the financial system (due to their leveraged positions). Easier access to international finance and so to financial leverage, due to their nature of trading houses with strong financial expertise, has boosted revenues to levels close to those of big energy firms (see annex). Trading houses trade not only with their own proprietary capital, both in the physical and the financial marketplace, but also on behalf of other firms or as a direct counterparty of other commodity firms.

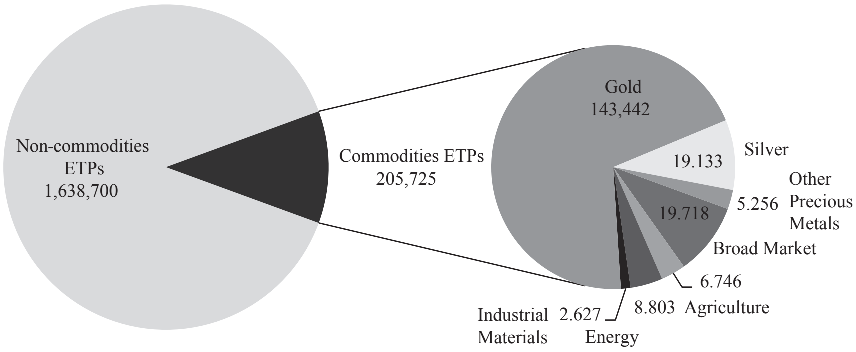
Finally, as mentioned above, new developments in financial markets and investment portfolio theories during recent years have paved the way to a new form of investment that spans across different asset classes. The entry of passive long investors in commodities markets is still source of great controversy in the academic literature. The following section reviews the literature and evaluates some empirical analysis.

aa) The Growth and Development of Commodities Index Investing and Other Financial Players

Index investing is an easy way to become exposed to a commodity without owning any underlying asset or without a commitment to deliver or buy any of them with daily margin calls (on futures markets). It can be considered one of the two main types of informed trading, with some particular characteristics (Masters (2008)). A clear distinction must be made with other non-commercial trading. First, even though often fully collateralised transactions by clients, indexes offer a position across a range of commodities without using expensive margin positions in futures markets or directly owning the commodity (with their storage risks and opportunity costs). Second, investors typically take a passive long position through these instruments on a basket of commodities.[9] Third, investors tend to hold these positions for a long period. This last aspect, in particular, differentiates them from classical informed traders, actively exploiting single pieces of information. There is no interest in trading the commodity, but rather in taking a position in these markets. Index investments bring important benefits to markets by offering an easily marketable exposure to an asset class with lower transaction costs than those (direct and indirect costs) involved in investing directly in futures markets or in holding the physical commodity. New players can enter markets and bring additional liquidity, increasing futures market access globally for all commodities market participants, whether physical or financial entities with an interest in physical assets. Their typically long and stable position favours those commodity firms (especially producers) that take short positions to hedge main business exposures. It also dilutes the dominant weight of the large physical players in the futures markets by also allowing small players to enter the market and take exposure.

The rise of index investing in futures markets has touched upon all asset classes and grown very rapidly in commodities, reaching over $200 billion of net value in March 2013 (over $366 billion, as sum of long and short positions), according to the U.S. Commodity Futures Trading Commission (CFTC) Index Investment data. The exchange-traded side of this business, in particular, has soared in recent years, reaching more than $200 billion of assets invested in 2012. There are also a number of products tracking indexes that are offered in the OTC space, which are captured in vast amounts by the CFTC statistics (above). Markets for commodities exchange-traded products have been growing rapidly since the onset of the financial crisis and they were reinvigorated in 2012, reaching

[9] As new indexes combining both long and short positions emerge (3rd generation indexes), the situation may move towards a more balanced combination of long and short positions.



Source: Blackrock ETP Landscape.

Figure 9: Breakdown of Commodities ETPs per Underlying Exposure, Q3 2012 (US$ Million)

a historical peak since their initial diffusion back in the early 2000s. However, most of these activities are concentrated in precious metals (in particular, gold), which may explain the nature of this type of investing as a tool to diversify investment risk in complex portfolios. The range of exchange-traded products (ETPs) is much broader and non-commodities ETPs are the biggest part of the market. Disregarding ETPs assets with exposures on precious metals, the size of ETPs in the commodities treated in this report goes down to roughly $38 billion (Figure 9).

Since the fund may be unable (for costs and type of risks) to take a direct position in different futures or physical markets to replicate the return of the index (with minimal errors; so called "physical replication"), the funds can also signs an OTC swap agreement with an investment bank that ensures the perfect replication of the index in exchange of a constant flow of liquidity from investors (through the fund) to the bank (physical replication). The bank will then take exposure in the futures markets using most of the financial flows (and collateral) coming from the fund, and by rolling over their futures positions held to ensure that the index is tracked with precision over time.

Figure 10 above shows the process through which investments in indexes are channelled through OTC and ETP products into futures markets, through the OTC swaps that funds sign with financial institutions.

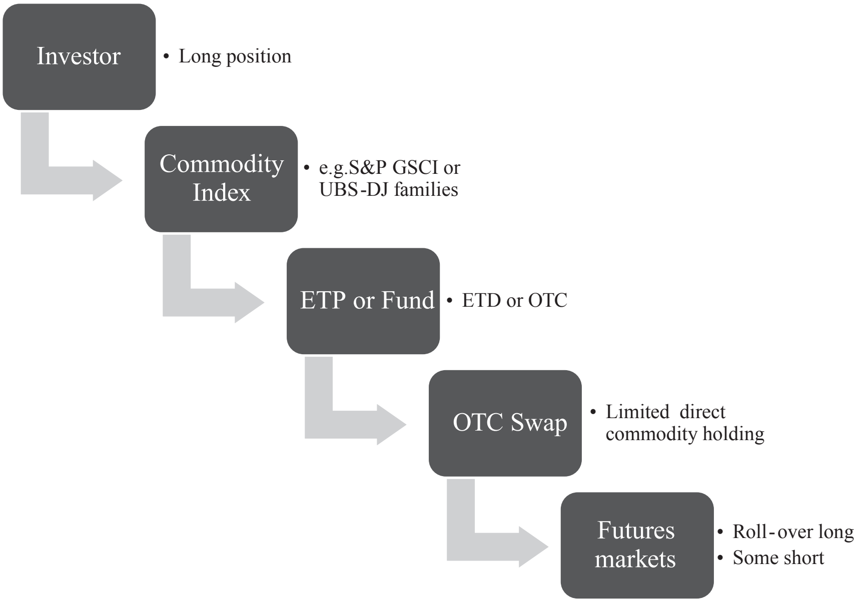
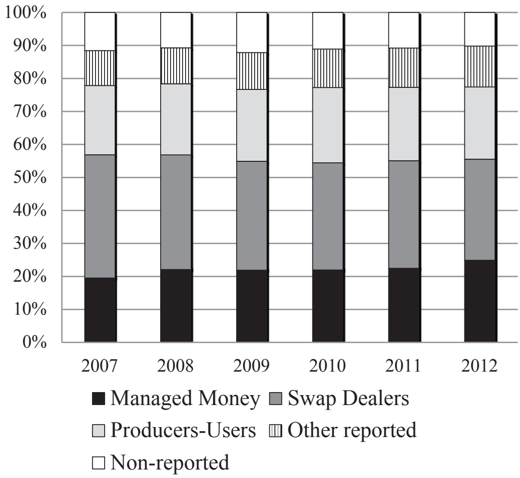


Figure 10: Index Investment Flows in Futures Markets

(1) CFTC Data on Futures Positions

Empirical analyses are typically based on CFTC positions of traders in US futures markets by type of entity (commercial and non-commercial) or purpose of investment (index investment, managed money, etc.)[10]. Across all US futures market, index investments have significantly increased their total position. However, CFTC data may be also controversial since the 'commercial/non-commercial distinction' underestimates commercial positions taken through dealers hedging OTC positions, while 'index investing' positions are available only for some futures contracts. In addition, by looking closely at the data, the series experience significant jumps until 2010–11, which may be signal of misreporting or new additions. From 2009, new Commitment of Traders (COT) data collected by CFTC shows instead a more granular overview of futures markets by type of trader going back to mid-2006. Type of trader, however, does not give a clear-cut distinction between pure commercial hedging

[10] The methodology of collection does not ensure that statistics may include some level of double-counting.

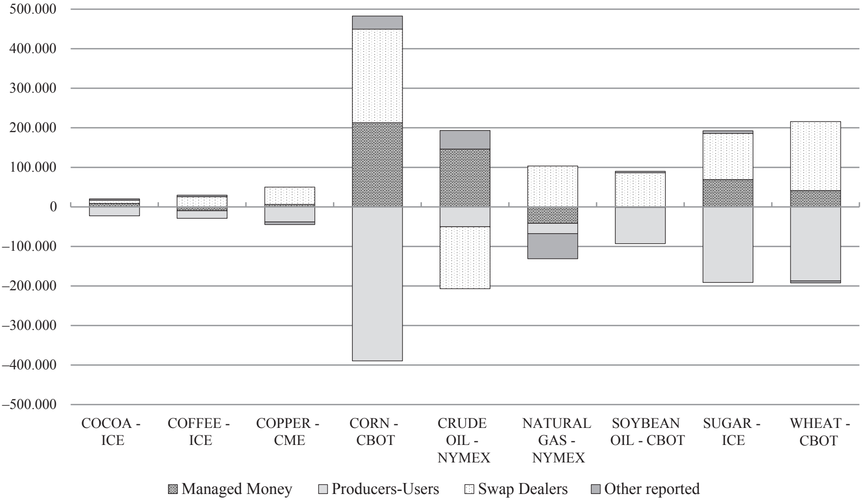


Source: Author's calculation from CFTC. Note: weighted average (by total open interest of corresponding contract each year) of 9 commodities futures contracts positions. Cocoa – ICE Futures US, Coffee C – ICE Futures US, Copper – Grade #1 – COMEX, Corn – CBOT, Crude oil – NYMEX, Natural gas – NYMEX, Soybean oil – CBOT, Sugar No. 11 – ICE Futures US, Wheat – (Chicago, Kansas, Minneapolis).

Figure 11: Open Interest by Type of Trader, 2007–2012

and speculation (informed and uninformed trading). The CFTC reporting splits data into 'managed money', 'swap dealers', and 'producers-users'. Managed money traders are investment funds (including hedge funds), i.e. participants engaging in futures trades on behalf of investment funds, but also investment trusts operated for the purpose of trading commodities (commodity pools). Commodity pools might also include non-financial players. Managed money traders are typically net long, but in some markets their net position might be short (as for natural gas in 2012). Swap dealers are largely financial institutions holding long positions, mainly to hedge (offset) derivatives contracts in OTC markets or to offer index funds products. Finally, producers-users are purely commercial players that usually have a net short position in futures markets in order to hedge price risk.

From the beginning of data collection (2006), however, the balance between categories of traders has not changed much. Managed money and swap dealers still represent over 50 % of total open interest, while producers-users' share is around 21 %, as is that of 'other reported' and 'non-reported' positions (Figure 11). The entry of financial players in US



Note: Difference between equally weighted average of long and short positions in 2012.

Source: Author's calculation from CFTC.

Figure 12: Net Positions by Type of Trader, 2012

commodities futures markets in the United States had been fuelled by deregulation in the early 2000s and was already a stable presence before the recent financial crisis.

By looking at net positions (difference between short and long open positions) of futures participants a different picture emerges. As Figure 12 suggests, commodities users and producers in 2012 are on average net short and major counterparty to other trading intents (e.g. speculation) represented by financial counterparties.

For crude oil and natural gas, instead, commodities producers and users hold a small net position (more balanced), while managed money and swap dealers are respectively net long and net short for crude, and respectively net short and net long for natural gas. This may also reflect an interdependence between oil and gas prices (*Panagiotidis/Rutledge* (2007)).

Furthermore, crude oil is the only futures contract where swap dealers are net short. Overall, net positions in crude oil and natural gas contracts are small in relation to the total size of the futures markets. Producers and users are more involved in spread trading. In fact, another characteristic of trading futures is the possibility to take advantage of a change in price relationships ('spread trading', as defined by the CFTC glossary), which also includes the essential tool of risk-free arbitraging for the liquidity of futures markets. This category mainly includes the so called 'calendar spread', trading spreads between maturities of the same futures contract (i.e. March versus July for corn futures). Spread trading has also been more or less stable since the beginning of data collection, but with large shares of the total open interest in crude oil and natural gas, where regional differentials play an important role for commodities users and producers. Both commercial and non-commercial market participants are active (calendar) spread traders.

More micro-structural analysis, with high-frequency data on open interests and volumes, is needed to assess the nature and the potential impact of spread trading. Unfortunately, the short data sample (from 2006) does not allow a long-term empirical analysis of the market implications of such practices.

(2) Evidence so far

More controversial is the discussion about the impact that index investing is producing on futures markets positions and, indirectly, on physical trades. No clear-cut evidence currently points to commodities index investments as the cause of a bubble or more volatile trends in commodities markets, by inflating the value of futures contracts with continuous roll-over of long futures positions that exercise upward pressures on prices (see, among others, *Irwin/Sanders* (2010)). *Büyüksahin* and *Harris* (2011) do not find any evidence that financial positions drove crude oil price changes during the historical peak in July 2008. *Gilbert* (with *Morgan* (2010), with *Pfuderer* (2012)) shows that trend-following informed trading is generally benign, and that index investments may even reduce volatility, by bringing stable flows of investments to markets. However, *Gilbert* (through Granger causality tests) and others (among them, *Mayer* (2009), *Tang/Xiong* (2010)) find that index investments and non-commercial trading have indeed pushed food prices upwards. Index investing positions lose significance when controlling for key structural factors, such as supply and demand (*Valiante* (2013)). Index investments appear to have been channelling information on macroeconomic factors into the price formation mechanism of futures contracts, but hardly changed price formation mechanisms. Greater flow of information into prices may reduce the probability of unpredictable events. Some temporary distortion in conjunction with the entry of non-commercial traders in the market and increased correlation with financial assets has been spotted too (*Tang/Xiong* (2010), *Silvennoinen/Thorp* (2010)), but it appears only to be a temporary departure from fundamentals (see *Vansteenkiste* (2011), assessing oil markets). As a result, this partial upward pressure on prices, driven by macroeconomic fundamentals, has been so far quantitatively negligible, also due to daily margin calls (if margin account drops below maintenance level due to a drop in prices), which put a cap on the potential expansion of the market into futures, and to the ultimate benefit that a passive long position across commodities can generate over time.

Additional causes behind the growth of financial positions, and in particular index investing following the recent 2008–09 financial crisis, shall be considered as well. Two important circumstances in recent years may have led to these market developments:

1. Growing funding needs of financial institutions and business diversification (sell-side).
2. Diversification of risk strategies (buy-side).

First, the implications of the financial crisis, such as soaring risk aversion (private sector deleveraging) and increasing capital and collateral needs to restore trust in the financial system, have caused liquidity to dry up and balance sheets to shrink.[11] Exchange-traded products in funds units, backed by a basket of commodities or an OTC swap, can raise liquidity for financial institutions (*Ramaswamy* (2011)) in exchange for tracking an index, which also typically generates excess returns for the bank. The fund manager, if it is not the bank, gets the transaction fee, while the financial institution benefits from the liquidity flows and generates excess returns. Finally, investment portfolio theories, led by early evidence from *Gorton* and *Rouwenhorst* (2004), have recognised to commodities an anti-cyclical pattern at the beginning of the century, which resulted in commodities becoming a key factor of diversification in buy-side risk strategies.

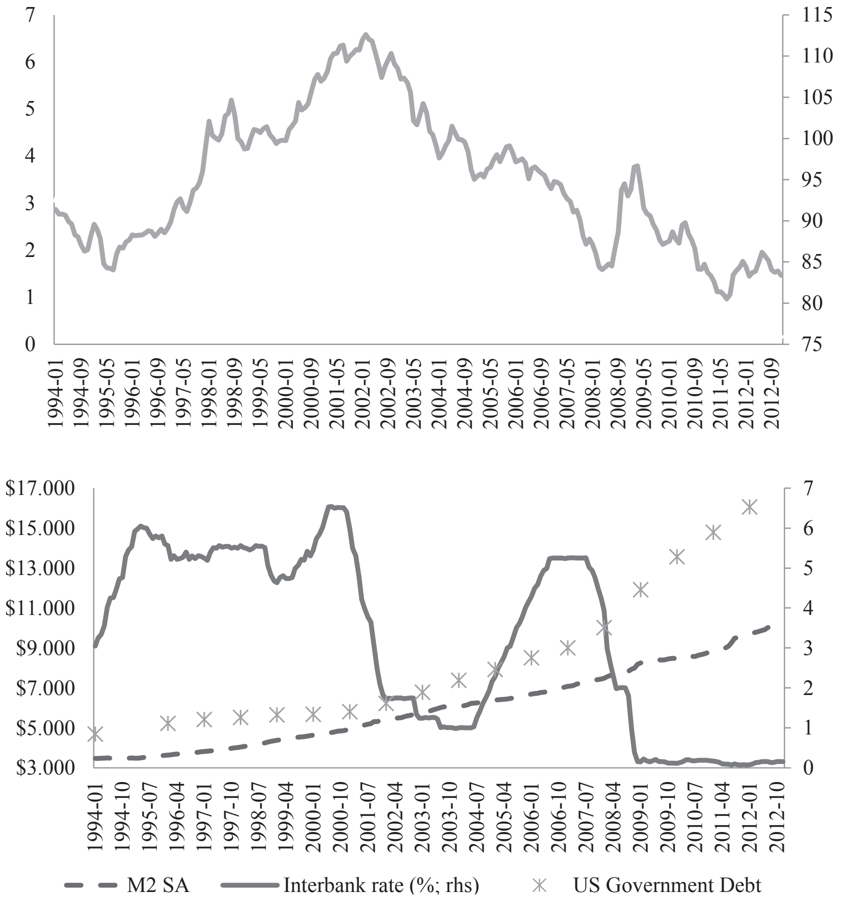
[11] Even if in a regional area such as the Eurozone the reduction of banks' balance sheet has been contained by repeated ECB interventions, the reduction of collateral available in the system has anyway increased the funding needs of financial institutions.

b) The Role of Expansionary Monetary Policies in the Expansion of Non-Commercial Players: an Empirical Analysis

Monetary policies have also influenced commodities prices in several ways, by mainly pushing money into the system to support the highly leveraged growth before and recently a strong deleveraging process. With a deleveraging process that fosters and is fostered by risk aversion and does not allow cash to meaningfully enter in the credit market, capital markets played the role of allocating this hoard of liquidity that continuously looks for risk diversification and returns across asset class. The distinctive passive position of index investor reflects this underlying search for asset diversification in a low-return and high-risk environment. As explained above, the academic literature (among others, *Gorton/Rouwenhorst* (2004)) has until recently supported this trading strategy, based on early evidence that commodities markets could have a counter-cyclical nature, so they could be considered an excellent tool to ensure diversification in portfolio management.

As also mentioned earlier, several authors have established a link between non-commercial positions in commodities and financial assets, claiming that such positions have been driving the growth of futures markets, causing the transfer of volatile patterns from financial to non-financial assets. More controversial is the role of monetary policies in this process. *Frankel* (2006) found empirical support for the claim that low interest rates push real commodity prices up. Most notably, this work confirms the findings of the economic theory on the negative impact of interest rates on the opportunity cost to carry on commodity inventories (*Borio* (2011)). This implies that monetary policies have a direct impact on commodities prices, at least through interest rates, thus establishing an intrinsic link between financial and non-financial assets. In addition, *Gruber* and *Vigfusson* (2013) argue that the increased correlation of commodities prices with financial indices can be mainly attributed (at least for some commodities, such as metals) to lower interest rates. Low interest rates also contribute to reduce volatility of commodities prices.

Moreover, the exchange rate is another transmission channel, representing the response function of the joint action of interest rates and changes in monetary aggregate, such as M2 also in the end influenced by real interest rates. Changes in the monetary aggregate would also capture unconventional central bank actions, which have become a tool frequently used to improve the transmission channel of monetary policies.



Source: Federal Reserve and US Treasury.

Figure 13: Broad Dollar Index (Inflation Adjusted)[12]
Devaluation and Policies, 1994–2012

Figure 13 shows how the dollar exchange rate has gradually devalued since 2002, as a result of bold cuts to nominal interest rates set by the central bank (and its effects on interbank rates) that started a prolonged

[12] The Broad Dollar Index is a weighted average of the foreign exchange values of the U.S. dollar against the currencies of a large group of major U.S. trading partners including 26 countries. The index weights, which change over time, are derived from U.S. export shares and from U.S. and foreign import shares. For more details, please see http://www.federalreserve.gov/pubs/bulletin/2005/winter05_index.pdf.

period of expansionary monetary policies in early 2000s, before attempting to correct it some years later with no success.

Expansionary monetary and fiscal policies, supported by global capital imbalances, thus were a key driver for the devaluation of the dollar, which began in 2002 and has recently reached a historical low since early 1990s (Figure 13).

The following section will assess what is the role of monetary policies in the growth of non-commercial positions and how non-commercial positions impact commercial ones. Notwithstanding the complex nature and implications of monetary policies, there appears to be a distinct pattern in which expansionary monetary policies may have played an important role for the growth of non-commercial (and commercial) positions, in particular via the quantity of money (M2)[13] that was injected in the system.

Due to misreporting in CFTC data, only a specific sample of non-commercial and commercial positions for a selected contract (crude oil, WTI) can be used for a more long-term analysis (with some strong caveats). Index positions, instead, are only available from 2006, which may not offer a sufficiently long-term analysis. Among other important factors that can influence commodities prices, over the long term, the impact of monetary policies has often been unpredictable (*Cooper/Lawrence* (1975)), which calls for a deeper investigation into their effects across asset classes, especially for commodities markets.

aa) VEC Analysis: Monetary Policies and Commercial Positions

In order to investigate in more depth the relationship between non-commercial positions and M2, for which a simple linear combination does not fit, and a more sophisticated empirical analysis is required. The following dataset (for crude oil US futures contract on NYMEX)[14] includes monthly data from January 1986 to December 2011:

- Total (or only short) commercial positions (log of open interest, 'LnComm').
- Total (or only long) non-commercial positions (log of open interest, 'LnNonComm').

[13] M2 consists of M1 (essentially, currency and similar in circulation, demand and other checkable deposits), plus savings deposits, time deposits, and money market funds, less individual retirement accounts.

[14] The only contract for which CFTC data on commercial and non-commercial futures positions gives a long-term series with very limited misreporting.

- Log of S&P 500 index, VIX index (implied volatility of S&P 500, 'SP500').
- Log of M2 (monetary aggregate, 'LnM2') and the Fed interbank interest rate (here called, 'Fed funds' or 'LnFedFund').

The dataset of futures positions for crude oil (commercial short and non-commercial long), despite changes to reporting criteria over the years, is the only CFTC legacy report that shows no significant jumps in the series since the beginning of data collection from CFTC in 1986, which may allow an assessment of long-term effects of monetary policies before and after the beginning of the expansionary era. As this dataset may underestimate the impact of swap dealers on non-commercial long positions, an additional empirical analysis with more granular data (available since 2006) is also run in the following section to confirm results. Moreover, this analysis uses monthly data, which do not permit the assessment of more short-term patterns. The results of this analysis, therefore, should be interpreted as an early assessment that is primarily valid over a sufficiently long time period.

Table 4

Summary Statistics

	LnNonComm LONG	LnNonComm TOT	LnComm SHORT	LnComm TOT	LnFedFund	LnM2	LnSP500
Mean	10.682	11.394	12.612	13.296	1.033	8.448	6.579
Standard Error	0.067	0.057	0.040	0.038	0.070	0.022	0.034
Median	10.447	11.109	12.631	13.336	1.586	8.383	6.822
Standard Deviation	1.182	1.016	0.699	0.674	1.244	0.382	0.601
Sample Variance	1.398	1.031	0.488	0.454	1.547	0.146	0.361
Kurtosis	–1.049	–1.046	–0.305	–0.118	1.644	–1.248	–1.286
Skewness	0.178	0.349	–0.430	–0.510	–1.650	0.284	–0.480
Range	5.379	4.151	3.277	3.163	4.947	1.344	1.990
Minimum	7.533	9.070	10.556	11.301	–2.659	7.828	5.356
Maximum	12.911	13.221	13.833	14.464	2.287	9.172	7.346
Count	312	312	312	312	312	312	306

Variables are stationary only in first difference (integrated of first order) and cointegrated (with stationary residuals), so linear regressions may be spurious and some Granger causality tests may give misleading results. *Engel* and *Granger* (1987) showed that the use of a simple linear regression with unit-root variables (even if de-trended) can generate numerous cases of spurious regression so, provided that a cointegration relation actually exists among the variables, the estimation of this relation is indeed quite powerful in avoiding misleading conclusions. The Vector Error Correction (VEC) model might be the best model to deal with variables subject to the same stochastic trend. VEC is an extension of a Vector Autoregressive Model (VAR) for variables that are non-stationary in levels, but stationary in their first difference (first-order integration, I(1)).[15] This model is particularly useful as it can take into account any relation of cointegration among two variables, i.e. they share the same stochastic trend.[16]

The first step checks cointegration among the variables. We run a regression of X (independent variable) on Y (dependent variable) in levels. We estimate the residuals of this regression (first step) and we test for the stationariety of the residuals through the Augmented Dickey-Fuller test (second step). If the residuals are stationary then the two variables are cointegrated[17].

First, a linear regression between commercial positions and M2 appears spurious, as hinted at by very high t-statistics and R-squared, as well as a very low Durbin-Watson d-statistics. Second, a test for the existence of a relationship of cointegration is performed.

The Dickey-Fuller test for unit root rejects the hypothesis (of unit root), so residuals of the cointegration equation (M2 regressed on commercial positions) are stationary and thus the two variables are cointegrated. The two variables move with the same stochastic trend and adjust through a process of error correction that is described in the Annex.

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[15] Testing hypotheses concerning the relationship between non-stationary variables is based on OLS regressions with data that had initially been differenced (*Granger/Newbald* (1974)). Although this method is correct in large samples, taking into account cointegration provides more a powerful analysis tool, as it doesn't lose information on long run equilibrium and on levels.

[16] While a deterministic trend is treatable by either regressing the variable on time (trend stationary) or eliminating the seasonality, to treat a stochastic trend and make the series stationary it is possible to just differentiate the variables.

[17] In this way we show that that there exists a linear combination of the 2 variables which is stationary, as the residuals u are nothing but $u = y - bx$.

Table 5

Linear Regression – Commercial Positions and M2

Source	SS	df	MS
Model	120.121401	1	120.121401
Residual	20.9564659	310	.067601503
Total	141.077867	311	.453626581

Number of obs	=	312
F(1, 310)	=	1776.90
Prob > F	=	0.0000
R-squared	=	0.8515
Adj R-squared	=	0.8510
Root MSE	=	.26

commTOT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnm2	1.62709	.0385993	42.15	0.000	1.55114	1.70304
_cons	-.4486328	.3264045	-1.37	0.170	-1.090881	.1936157

Durbin-Watson d-statistic(2, 312) = .1009832

Table 6

Augmented Dickey-Fuller Test

Augmented Dickey-Fuller test for unit root Number of obs = 310

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.909	-3.455	-2.878	-2.570

MacKinnon approximate p-value for Z(t) = 0.0020

D.coin1	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
coin1						
L1.	-.0707039	.0180856	-3.91	0.000	-.1062914	-.0351165
LD.	-.1069497	.055503	-1.93	0.055	-.2161641	.0022646
_cons	.0024848	.004561	0.54	0.586	-.00649	.0114596

The Granger Theorem states that if Y and X are cointegrated, the relationship can be written as below and at least one between γ_1 γ_2 *must* be ≠ 0.

(eq.1) $$\Delta Y_t = a_1\,\Delta Y_{t-1} + b_0\,\Delta X_t + b_1\,\Delta X_{t-1} + \gamma_1(Y_{t-1} - X_{t-1})$$

(eq.2) $$\Delta X_t = a_1\,\Delta X_{t-1} + b_0\,\Delta Y_t + b_1\,\Delta Y_{t-1} + \gamma_2(Y_{t-1} - X_{t-1})$$

γ_1 and γ_2 are the coefficient of the cointegrating equation. At least one of them must be statistically different from zero and with *negative coefficient,* as it shows how a variable, when the distance between the two variables grows, is brought back to the equilibrium and the model is then stable. Those coefficients should then be between 0 and –1. It is the *speed of adjustment* of the dependent variable to the equilibrium. For instance, if it is equal to 0.5 it means a 50 % movement back to equilibrium follow-

Table 7

VEC Analysis Outputs

Source	SS	df	MS
Model	.177201164	3	.059067055
Residual	1.89063841	306	.006178557
Total	2.06783957	309	.006692037

Number of obs	=	310
F(3, 306)	=	9.56
Prob > F	=	0.0000
R-squared	=	0.0857
Adj R-squared	=	0.0767
Root MSE	=	.0786

D.commTOT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
commTOT						
LD.	-.104876	.0548934	-1.91	0.057	-.2128924	.0031404
lnm2						
D1.	-2.367319	1.075996	-2.20	0.029	-4.484607	-.2500303
coin1						
L1.	-.0812382	.0178908	-4.54	0.000	-.1164428	-.0460336
_cons	.0205437	.006461	3.18	0.002	.0078301	.0332574

Source	SS	df	MS
Model	.000257564	3	.000085855
Residual	.005211015	306	.000017029
Total	.005468579	309	.000017698

Number of obs	=	310
F(3, 306)	=	5.04
Prob > F	=	0.0020
R-squared	=	0.0471
Adj R-squared	=	0.0378
Root MSE	=	.00413

D.lnm2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnm2						
LD.	.0947919	.0571094	1.66	0.098	-.017585	.2071687
commTOT						
D1.	-.006499	.0029625	-2.19	0.029	-.0123284	-.0006696
coin1						
L1.	-.0026633	.0009751	-2.73	0.007	-.004582	-.0007446
_cons	.0039853	.0003435	11.60	0.000	.0033093	.0046612

ing a shock to the model one period later. If it is equal to 1 then there is full adjustment to the equilibrium the period after. A coefficient higher than 1 would not make much sense.

The VEC analysis (described in Table 7) for the relation between the number of commercial positions in the crude oil futures market and M2 shows that the cointegration equations for both variables are statistically significant. Most notably, commercial positions react much faster to equilibrium shocks (8 % rate) compared to M2, whose coefficient is negligible. This result may indicate that commercial positions are affected by monetary policy actions much more than the other way around. The coefficient b_1, which weights the impact of the cointegrated (lagged) variable on the dependent, is non-significant for M2, i.e. the lagged value of commercial position has no link with M2. The same is not true for commercial positions, as the lagged value of M2 is statistically significant.

With this modified Granger, the conclusion is that M2 Granger-causes commercial positions and not vice-versa.

We apply the same approach to non-commercial positions and M2. As shown by Output #3 (annex), non-commercial positions adjust to equilibrium with M2 at an 18 % rate. It therefore appears that are the non-commercial positions 'to follow' changes in M2. This is confirmed by the cointegrating coefficient of M2, which is not significant, hinting at the indifference of M2 towards the distance from equilibrium with non-commercial positions.

Finally, the same approach is used to assess the relationship between non-commercial long positions, which represent passive speculative investments that would supposedly divert futures markets from their fundamentals, and commercial short positions (a classic commodities hedge for final users). The initial test (Output #4) confirms that the regression is spurious and residuals are stationary, so variables can be considered cointegrated. The VEC analysis (Output #5) gives some interesting results. The cointegrating equation of a non-commercial long position has a statistically significant (at 1 %) negative coefficient, which suggests that these positions react at deviations from equilibrium with commercial short positions. The opposite is not true. The cointegrating coefficient is significant at 5 %, but with a very low positive coefficient. This points to an unstable equilibrium, so we could potentially ignore it. As a result, commercial short positions Granger-cause non-commercial long.

The growth of commercial players and the general interests in physical commodities markets in the last decade, with the quick and intense development of international trade, have proved fertile ground to promote the growth of non-commercial positions as a tool to provide liquidity, which could be accessed at very low costs due to accommodating monetary policies. This finding is in line with ample evidence showing, despite the potential to be harmful for price formation through herding behaviours, limited distortive effects of financial positions on commodities price formation.

bb) Taking Stock from the New CFTC Disaggregated Reporting

While the previous long-term price formation analysis with the legacy reports should be still valid over a long-term database (from 1986), the growth of passive investments together with other (typically long) swap dealers positions in recent years requires further analysis with the new

Table 8

Granger Causality Tests

Variables	Granger causality			Reversed		
Independent → Dependent	Crude oil	Natural gas	Corn	Crude oil	Natural gas	Corn
M2→SD/MM long	Yes*	No	No	No	No	Yes***
M2→Producers short	No	Yes*	Yes*	No	Yes*	No
Producers short → SD/MM long	Yes**	Yes**	Yes**	No	No	No

Note: *1 %, **5 %, ***10 % significance. 'SD/MM' stands for 'Swap dealers/Managed money'. See also outputs in Annex.

CFTC reporting system that was launched in 2009 and goes back to 2006. The new reporting, therefore, disaggregates data on futures open positions in three main categories of traders (producers, swap dealers and managed money). The analysis uses the new CFTC dataset, which includes weekly data on open positions for the three most liquid futures contracts in the US (crude oil, natural gas, and corn). The analysis in the previous section is replicated by running Granger causality tests. The Dickey-Fuller test suggests that variables are not co-integrated and Granger causality tests shall not thus lead to misleading results. Different lags for each futures contract have been considered, in line with lag-order selection statistics.

Table 8 confirms the results of the previous analysis but it qualifies it further. It confirms that M2 leads producers positions, which points at the potential impact of prolonged expansionary monetary policies on non-financial assets (through expansion of monetary base). However, from 2006, data for crude oil confirms an impact of the monetary base on the size of financial players' positions in futures markets, while the impact of the monetary base only affects producers/users' positions for natural gas and corn futures positions. Due to their constant growth in crude oil futures markets, non-commercial positions have become the main mean to transfer effects of policies and events that affect the monetary base.

Most notably, the analysis on the disaggregated futures positions confirms the results of the earlier vector error correction model by ascertaining the role of producers/users position in guiding swap dealers and managed money's long positions (and not vice versa) for the top three futures contracts (by size of open interest). Financial futures positions still complement non-financial ones and are shaped by the latter. Therefore, the nature and the role of non-commercial players' participation in commodities markets appears benign and essential for the development of commercial positions, and thus attention should rather focus on short-term market practices led by non-commercial players that could potentially lead to damaging herding behaviour (*Boyd* et al. (2013)). Short-term price trends and market practices shall be subject to more detailed analysis, which would require more detailed information about traders' behaviours (e.g., data on volumes by category of trader).

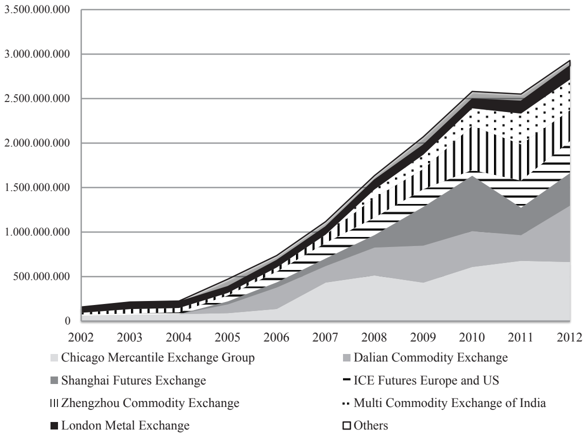
3. *A Story of Fast-Growing Market Infrastructure*

Market infrastructure plays a crucial role in the development of commodities market structure and its well functioning on a global scale. Futures markets, in particular, are an essential infrastructure supporting risk management, and ultimately price formation in physical markets. Futures markets have supported the development of international trade and the consolidation of commercial participants fuelled by the opening up of international trade. Transparent and stable futures markets promote healthy interaction between the physical and financial spheres of commodities markets, which today are inextricably linked. As a result of greater interconnectedness, market infrastructure also allows faster circulation of information by increasing accessibility and so the resilience of price formation mechanisms.

The size of commodities futures exchanges has more than tripled since 2004, particularly as a result of the financial crisis, which has reduced dealers' capital commitment in OTC derivatives transactions (see table in annex) and increased the role of transparent venues as a cheaper source of liquidity for commodities users. The size of global commodities futures exchanges reached its peak in 2012, with almost 3 billion traded contracts and seven global market infrastructures of which no one is European and four of them are today Chinese companies (see Figure 14).

The development of market infrastructure in recent years has been astonishing and driven by the following events:

- Demutualisation;
- Technological advances; and
- Regulatory reforms.



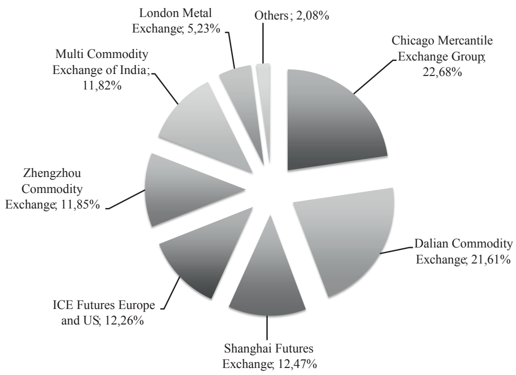
Note: 2012 data for Multi Commodity Exchange of India is from 2011.[18]

Source: Author's calculations from World Federation of Exchanges (WFE) Statistics and the European Capital Markets (ECMI) Institute Statistical package (2012).

Figure 14: Growth of Commodity Futures Exchanges Volumes by Number of Contracts, 2002–2012

Around the early 2000s, as technological changes showed that trading venues are not natural monopolies and can stand market competition, a process of demutualisation of otherwise no-profit entities began. Demutualisation triggered a more competitive environment with for-profit entities investing to increase market share and profitability, mainly through new services to boost volumes and consolidation with other incumbent infrastructures. In commodities markets, US and Chinese exchanges are leading participants in futures market infrastructure. As shown in Figure 15, the Chicago Mercantile Exchange (CME) group is the biggest global exchange by value of open interest and number of traded contracts, but the growth of Chinese exchanges has been astonishing, and today they have a global market share of almost 50 %, as China has de facto become the major commodities consumer in the world (Figure 15). Some Chinese exchanges have become points of reference in Asia but, also due to gov-

[18] 'Others' include: MICEX / RTS, NYSE Euronext (Europe), Bursa Malaysia Derivatives, ICE Futures Canada, Thailand Futures Exchange, Johannesburg SE, BM&FBOVESPA, ASX SFE Derivatives Trading, Korea Exchange, Buenos Aires SE, NYSE Euronext (US), Rofex, ASX Derivatives Trading, BSE India, Bursa Malaysia, Japan Exchange Group – Osaka, Tokyo Commodity Exchange (TOCOM), Tokyo Grain Exchange.



Note: Data for Multi Commodity Exchange of India is from end of 2011.

Source: Author's calculations from WFE and ECMI (2013).

Figure 15: Global Commodity Futures Exchanges Volumes by Number of Contracts, 2012

ernance issues and legal uncertainty in these emerging economies, most of benchmark futures prices are still formed on trading venues located in Europe and the US.

However, the trading landscape is still on the move and global competition may lead to additional attempts at consolidation. The recent acquisition of NYSE LIFFE by ICE will certainly increase ICE's global market share and will perhaps create the biggest European commodities exchange. Most importantly, the merger follows the path of consolidation between European and US exchanges striving to increase their market share and market power at the global level. Given the similar underlying macroeconomic conditions and financial systems of the two regions, cross-border merger and acquisition activities may find more solid ground for synergies and economies of scale to develop, as often seen in recent years.

Furthermore, the evolution and growth of commodity futures exchanges has followed the development of new legal and technological tools, which have made the trading process more standardised and suitable for electronic trading. On the legal side, future contracts traded on exchanges have been improved in four key areas: quantity, delivery dates, delivery points (among a list), and quality grade. On the technological side, the 'electronification' of trading has fit squarely into the modern developments of commodities markets and electronic trading has almost completely taken over the old open outcry ('the pit'). Almost all futures trading is done today through an electronic platform, which increases the speed and volumes of transactions, reduces access costs, and provides a single access point from any location around the world, often 24/7. Obviously, the diffusion of electronic trading may also carry costs, which are mainly linked to complex operational aspects, i.e. the ability to handle new technologies and computer algorithms (e.g. high-frequency trading) smoothly and to supervise complex operations that could potentially turn into market manipulation (e.g. 'cornering' practices). However, technology also offers the ability to detect abusive practices through new and sophisticated tools.

Finally, implications of current regulatory reforms on the market power of global infrastructures require further investigation. Commercial interest around new services that are generally considered not profitable (such as trade repositories) points at the market power generated by the economies of scale and scope that providing this service may offer, in combination with several trading, clearing and settlement services that vertically integrated market infrastructures already offer to clients. As the industry pushes for consolidation at regional and global level, a minimum set of requirements to ensure accessibility and interaction with competitors while preserving rights on key intellectual properties may be beneficial for the innovation around new products and services to attract liquidity and, ultimately, serve the interests of commodity users. A world of fragmented and inefficient commodities markets is happily a memory of the past, but internationalisation and interconnection also means concentration of international trading in a handful of global companies and market infrastructures, which have to remain accountable for their actions and fully transparent. The governance and supervision of market infrastructure (e.g. conflicts of interest) is important element for price formation, by ensuring a smooth convergence of futures to spot (physical) prices and so the price efficiency of recognised international benchmark prices.

III. The Meaning of Financialisation: Some Empirical Evidence

The increasing interaction of commodities markets with the financial system over the last decade is commonly referred to as 'financialisation'. 'Financialisation' can be defined as the process of alignment of commodities returns with pure financial assets returns ('pooling effect'), so increasing co-movements among asset classes that have been historically seen as following opposite causal patterns. This process began well before the financial crisis, and more precisely when the growth of interna-

Table 9

Link Between Commodities Prices and S&P500 Before and After 2002
(Author from Valiante, 2013)

	Before 2002	After 2002	Whole sample	Model
Crude oil	No	Yes	No	ARCH
Natural Gas	No	No	No	ARIMA, Granger
Aluminium*	No	Yes	Yes*	ARCH, OLS
Copper	No	Yes	No	ARCH, OLS
Wheat	No	Yes	No	ARIMA, OLS
Corn	No	Yes	No	OLS
Soybean oil	No	Yes	Yes	ARCH, OLS
Cocoa	Yes**	Yes**	Yes**	OLS
Coffee	No	Yes**	No	OLS

Note: *both ways, **Rejection at 10 % level. Data up to 2011/2012.

tional trade, greater access to international finance and liquidity, and key market infrastructure developments began to deploy their effects on market structure in the early 2000s. As reported in a recent work (*Valiante* (2013)), and summarised in Table 9, a link between commodities prices of eight key storable commodities and S&P 500 emerged only after early 2000s, by taking as reference year 2002. Among other important events, 2002 is the first year of China in the WTO, the first year after expansionary monetary policies following the 2001 crisis and the dotcom bubble, as well as crucial period following the demutualisation of major exchanges around the globe.

Granger causality tests may also help to explore how policies (monetary policies, in particular) have influenced the relationship between commodities and financial indicators, providing fertile ground for passive investments to grow. Due to its characteristics, the model tests the 'causal' link between commercial, non-commercial, and non-commercial long with the implied volatility of the S&P 500 index, the so-called VIX. Data are weekly and, over the period 1992–2011, only CFTC open interest positions from the WTI crude oil futures contract are available with no significant misreporting. The test is performed for three time periods:

(a) 1992–2011

(b) 1992–2001

(c) 2002–2011

Table 10

Granger Causality Test Summary

Dependent Variable	Independent Variable	1992–2011	1992–2001	2002–2011
Commercial	VIX	Yes*	No	Yes***
VIX	Commercial	No	No	No
Non-commercial	VIX	No	No	No
VIX	Non-commercial	No	No	No
Non-commercial Long	VIX	Yes***	No	Yes*
VIX	Non-commercial Long	No	No	No

Note: *1 % **5 % ***10 % significance (*p-value*). 997 observations. See Output #7, Output #8, and Output #9 in annex for more details.

As Table 10 shows, non-commercial positions appear not linked with VIX, but non-commercial long positions (including index investing) and commercial positions are. The fact that none of the positions Granger-causes volatility on S&P 500 may point to a one-way relationship. Most interestingly, the relationship between commercial/non-commercial long positions and the VIX does not exist before 2002, but emerges with the joint effects of the three narratives mentioned above.

To sum up, the birth of massive non-commercial positions appears to be driven by the growth of commercial players and the expansion of international markets, which found fertile ground thanks to expansionary monetary policies. The growth of non-commercial positions, and in particular long passive investments (index investing), was mostly supported by expansionary monetary policies (and cheap credit) that have improved access to finance and promoted price changes across asset classes. The analysis therefore confirms *Frankel*'s earlier (2006) findings, which were limited in scope to links between interest rates and broader commodities indexes. The analysis here takes for granted the link with interest rates and develops further work on the monetary base (M2). Finally, a prolonged long period of easy access to finance has also contributed to the rise in correlation between financial and non-financial assets, as the analysis on the VIX clearly shows. Considering developments in other commodities futures markets, the key findings of this analysis, which relies on crude oil futures positions, could potentially be extended to other markets. However, the lack of reliable information over a sufficiently long period calls for prudence in using this data for more long-term analyses.

IV. Conclusions: the World After Financialisation

In recent years, the structure of commodities markets has dramatically changed under fast-growing international trade, a more sophisticated financial structure and a more efficient market infrastructure. These three narratives have changed commodities markets for the foreseeable future. As benchmark prices are gradually expanding the actual coverage of physical markets to a more global level, they include way more information into prices and so increasing efficiency in pricing underlying physical market transactions. However, prices have been also exhibiting greater short-term volatility and structural shifts in price levels, as growth in underlying volumes embed more information about global and regional supply and demand imbalances, together with much lower ability for national governments (as more costly) to provide fiscal pocket to meaningful subsidies programmes able to influence market prices. As those three narratives promoted global commodities flows and less artificial price distortions, more information into prices also means more interconnection among physical markets. Greater access to international finance, instrumental to cross-border commodities trades, has boosted the number of commodities-linked financial transactions and promoted the entrance of new financial market actors. Expansionary monetary and fiscal policies, driven by global capital imbalances, have been at the centre of these market developments and ultimately resulted in pooling effects, namely the alignment of commodities returns with pure financial assets returns.

As a result, greater interconnection with the financial system and so vulnerability to shocks in markets that are apparently unlinked is a key emerging factor of this new market structure. More efficient price discovery also means a more complex interconnection between commodities and financial markets. Both futures and physical markets (and infrastructures) become therefore systemically important for their direct effects on global pricing of commodities. An efficient convergence of futures prices to underlying physical market prices preserves the stability of these markets and becomes a key objective for policy-makers. A new scenario for policy-making in global commodities markets emerges and inevitably has to rely much less on national actions and more on an internationally coordinated action to face market failures that affect price convergence for key regional and international benchmark prices.

On a microstructural level, many questions still remain open in areas such as the interaction between futures and physical markets and the impact of intra-day volumes on more long-term price formation mechanisms. From an early empirical analysis, this paper concludes that categories of traders are not distorting per se commodities price formation mechanisms. However, more evidence is needed on the impact of intra-day volumes and changes in open interest, which are not part of this analysis. More information is also needed on physical transactions, in order to know more about the 'natural' divergence between physical and futures market prices.

References

Borio, Claudio (2011): Central banking post-crisis: What compass for unchartered waters?, BIS Working Paper, N. 353.

Boyd, Naomi E./*Büyüksahin,* B./*Harris,* Jeffrey H./*Haigh*, Michael S. (2013): The Prevalence, Sources, and Effects of Herding, Working Paper, 27 February (http://ssrn.com/abstract=1359251).

Büyüksahin, B./*Harris*, Jeffrey H. (2011): Do speculators drive crude oil futures prices, Energy Journal, Vol. 32, N. 2, pp. 167–202.

Clark, Ephrain/*Lesourd,* Jean-Baptiste/*Thiéblemont*, René (2001): International Commodity Trading: Physical and Derivative Markets, Chichester: John Wiley & Sons Ltd.

Cooper, R./*Lawrence*, R. (1975): The 1972–75 Commodity Boom, Brookings Paper on Economic Activity, Vol. 64 1–715, pp. 716–723.

Engle, Robert F./*Granger*, Clive W. J. (1987): Co-integration and error correction: Representation, estimation and testing, Econometrica, Vol. 55, N. 2, pp. 251–276.

Fama, Eugene/*French,* Kenneth (1988), Business Cycles and the Behavior of Metals Prices, Journal of Finance*, Vol.* 43. N. 5 (1988), pp. 1075–1093.

Frankel, J. (2006), The Effect of Monetary Policy on Real Commodity Prices, in Asset Prices and Monetary Policy (2008), University of Chicago Press.

Geman, Helyette (2005): Commodities and Commodity Derivatives: Modelling and Pricing for Agriculturals, Metals and Energy, Wiley Finance.

Gilbert, C./*Morgan*, W. (2010): Food Price Volatility, Philosophical Transactions of the Royal Society, 365(1554), pp. 3023–3034.

Gilbert, C./*Pfuderer*, S. (2013), The Financialization of Food Commodity Markets, Forthcoming in Jha, R./Gaiha, T./Deolalikar, A. (eds.), Handbook on Food: Demand, Supply, Sustainability and Security.

Gorton, G./*Rouwenhorst*, K. G. (2005): Facts and Fantasies about Commodity Futures*,* Yale ICF Working Paper No. 04-20*,* February.

Granger, C./*Newbold*, P. (1974): Spurious regressions in econometrics, Journal of Econometrics, 2, pp. 111–120.

Gruber, Joseph W./*Vigfusson*, Robert J. (2013): Interest Rates and the Volatility and Correlation of Commodity Prices, Board of Governors Federal Reserve System, International Finance Discussion Papers, N. 1065, January.

Irwin, Scott H./*Sanders*, Dwight R. (2010): The impact of index and swap funds on commodity futures markets, OECD Food, Agriculture and Fisheries Working Papers 27, 52.

Mayer, J. (2009): The Growing Interdependence Between Financial and Commodity Market, UNCTAD discussion paper n. 195.

Nomikos, N. (2012): Managing Shipping Risk in the Global Supply Chain. The Case for Freight Option, Cass Business School Presentation (http://www.bbk.ac.uk/cfc/papers/nomikos.pdf).

Panagiotidis, T./*Rutledge*, E. (2007): Oil and gas markets in the UK: Evidence from a cointegrating approach, Energy Economics, 29, Issue 2, pp. 329–347.

Pindyck, R. (1994): Inventories and the Short-Run Dynamics of Commodity Prices, The American Journal of Economics, Spring 1994, 25, pp. 141–59.

– (2001): The dynamics of commodity and futures markets: a primer, Energy Journal 22, pp. 1–29.

Ramaswamy, S. (2011): Market structures and systemic risks of exchange-traded funds, BIS Working Paper, n. 343, April.

Rumbaugh, T./*Blancher*, N. (2004): China: international trade and WTO accession, International Monetary Fund.

Silvennoinen, A./*Thorp*, S. (2010): Financialization, Crisis and Commodity Price Dynamics, Journal of International Financial Markets, Institutions and Money, 24(1), pp. 42–65.

Tang, K./*Xiong*, W. (2009): Index Investing and the Financialization of Commodities, Working paper, Princeton University.

Valiante, D. (2013): Commodities Price Formation: Financialisation and Beyond, Centre for European Policy Studies Paperback, Brussels.

Vansteenkiste, I. (2011): What is driving oil futures prices? Fundamentals versus speculation, ECB Working Paper Series, N. 1371, August.

US-China Business Council (2010): Testimony of John Frisbie, President, Trade Policy Staff Committee Hearing (https://www.uschina.org/public/documents/2010/10/wto_commitments_testimony.pdf).

World Trade Organisation (2001): WTO successfully concludes negotiations on China’s entry, Press Release, 17 September (http://www.wto.org/english/news_e/pres01_e/pr243_e.htm).

Annexes

Tables

Growth of Exports Value ($bn) and Size, 2001–11

	Value ($bn)			Size		
	2001	2011	CAGR	2001	2011	Units
Crude oil	340.1	1,475	16%	38,262.1	38,854	kbbl/day
Natural Gas	82.4	368.5	16%	553.46	1073.32	bcum
Iron ore	14.8	180	28%	493.1	1,072.9	mn/tonnes
Wheat	19.1	47.6	10%	105.92	150.4	mn/tonnes
Aluminium*	16	38.1	9%	11.1	15.87	mn/tonnes
Corn	6.7	34.1	18%	74.67	117.03	mn/tonnes
Coffee	5.4	28.6	18%	5.45	6.81	mn/tonnes
Sugar	4	17.8	16%	21.11	31.12	mn/tonnes
Soybean oil	2.9	11.1	14%	8.25	8.52	mn/tonnes
Cocoa	2.6	8.8	13%	2.47	2.96	mn/tones
Copper	na	Na	na	na	na	Na

Source: Author's calculation from World Bank, USDA, ABREE, BP, OPEC, FAO. Note: *Data on exports are estimates.

China's Ranking in Key Commodities Markets, 2001–2011/2012

	Production (top 10; % tot)		Consumption (top 10; % tot)		Exports (top 10; % tot)		Imports (top 10; % tot)	
	2001	**2011/2012**	**2001**	**2011/2012**	**2001**	**2011/2012**	**2001**	**2011/2012**
Crude oil	7th (4.4%)	5th (4.9%)	3rd (6.3%)	2nd (11.1%)	no	no	n/a	2nd (14.9%)
Natural Gas	n/a (1.2%)	6th (3.1%)	n/a (1.1%)	4th (4.1%)	no	no	n/a	10th (1.2%)
Iron ore	n/a	2nd (22.9%)	n/a (13%)	1st (50%)	no	no	n/a	1st (60.2%)
Aluminium	2nd (13.5%)	1st (41.8%)	n/a	1st (41.5%)	no	no	5th *	10th
Copper	n/a	1st (26.4%)	n/a	1st	no	no	n/a	1st
Wheat[a]	2nd (16%)	2nd (7.7%)	2nd (18.5%)	2nd (17.9%)	no	no	no	no
Corn[a]	2nd (19%)	2nd (15%)	2nd (19.8%)	2nd (22.4%)	no	no	no	no
Soybean oil[a]	4th (12.4%)	1st (26.2%)	2nd (14.7%)	1st (28.9%)	3rd	1st	no	no
Sugar[a]	5th (5.2%)	4th (7.2%)	5th (6.7%)	3rd (9%)	no	no	7th	4th
Cacao	no	no	no	no	no	no	9th	8th
Coffee	no	no	no	no	no	no	no	no

*In 2003. [a]2012 estimate.

Source: Author's calculation from IMF Database, BP, OPEC, ICSG, USDA and other governmental authorities.

Top 12 Most Active Financial Institutions in Commodities Derivatives, by Notional/Total Assets

€bn – End 2011	Notional value[19]	Gross value (fair value)*	Total assets	Revenues	% Notional/ Total assets	% Gross/ Total assets	Ratio Gross/ Revenues
Morgan Stanley	607.07	61.60	579.00	25.02	104.85%	10.64%	246
Goldman Sachs	614.91	57.51	712.82	22.25	86.26%	8.07%	2.59
JP Morgan	859.35	90.62	1,749.42	75.07	49.12%	5.18%	1.21
Barclays	857.09	26.89	1,876.86	38.76	45.67%	1.43%	0.69
Bank of America	639.22	29.65	1,643.84	72.91	38.89%	1.80%	0.41
Credit Suisse	281.62	n/a	862.41	21.56	32.65%	n/a	n/a
Société Générale	343.09	17.06	1,181.37	25.64	29.04%	1.44%	0.67
Deutsche Bank**	459.13	44.36	2,164.10	33.23	21.22%	2.05%	1.34
Citigroup	221.11	21.92	1,446.82	60.50	15.28%	1.52%	0.36
BNP Paribas**	156.29	13.75	1,965.28	42.38	7.95%	0.70%	0.32
Credit Agricole	69.79	8.50	1,860.00	35.13	3.75%	0.46%	0.24
HSBC	59.06	2.85	1,973.16	46.44	2.99%	0.14%	0.06
Tot.	5,167.7[2]	374.71	18,015.09	498.88	49.71%^	3.9%^	1.15^
Global OTC	2,57[20]	405	–	–	–	–	–
Global ETD***	3,585	–	–	–	–	–	–

Source: 2011 Annual reports, SEC K10 files, BIS (2013 update), WFE/IOMA. *Before netting adjustments. ^Weighted average (notional). "Estimates. ***Conservative estimate of value of traded futures and options contracts.[21]

[19] Balance sheets do not provide further granularity on how this notional value can be decomposed, i.e. what kind of commodities derivatives trades (OTC or it includes estimation of exchange-traded derivatives positions in commodities). It includes precious metals. For exchange-traded futures contracts, notional value in this analysis means value of open interest.

[20] Including OTC derivatives on gold and other precious metals, at the end of 2012.

[21] These statistics do not include the turnover value of commodities futures and options of the London Metal Exchange, NYSE Euronext (US), Australian Securities Exchange SFE Derivatives Trading, Multi Commodity Exchange of India, Singapore Exchange, plus an undefined list of small commodities exchanges.

Notional Value of Outstanding Commodities Futures and Options Traded OTC and on Exchange ($bn)19

	Exchange-traded		Over-the-counter		Total	
	2011	2012	2011	2012	2011	2012
Futures[22]	3,226 (65%)	3,168 (70%)	1,745 (35%)	1,363 (30%)	4,971	4,531
Futures and options	3,585 (58%)	3,485 (62%)	2,570 (42%)	2,101 (38%)	6,155	5,584

Note: Exchange-traded data are conservative estimates derived from turnover value of futures and options contracts.[23] Value of over-the-counter positions is not daily marked-to-market.

Source: Author's estimates from WFE/IOMA, BIS, CME, LIFFE, LME, ICE, other sources.

22 Forwards and swaps for OTC transactions.

23 The statistics published by the World Federation of Exchanges and the International Options Market Association do not include the turnover value of commodities futures (forwards) and options traded on the London Metal Exchange, NYSE Euronext (US), Australian Securities Exchange SFE Derivatives Trading, Multi Commodity Exchange of India, Singapore Exchange, plus an undefined list of very small commodities exchanges.

Key Trading Companies by Total Revenues, 2003 vs. 2011 ($bn)

		Ownership	Country	Total assets		Total revenues		
				2003	2011	2003	2011	2003–11 CAGR
1	Vitol	Private	Netherlands	na	na	61*	297.00	22%*
2	Glencore	Public	Switzerland	59.90**	86.16	142.34**	186.15	-
3	Trafigura	Private	Netherlands	na	na	na	121.50	-
4	Noble group	Public	Hong Kong	1.07	17.34	4.28	80.73	44%
5	Gunvor International	Private	Cyprus	na	na	na	80.00	-
6	Mercuria	Private	Switzerland	na	na	na	75.00	-
7	Marubeni***	Public	Japan	41	65	75.2	55.63	-
8	Xstrata	Public	Switzerland-UK	10.00	74.83	3.47	33.88	33%
9	Marquard & Bahls AG	Private	Germany	0.78	5.63	5.44	25.84	22%
10	System Capital	Private	Ukraine	na	28.45	na	19.55	-

Note: *2004 data; **2007 data; *Fiscal year ended in March 2012. Exchange rate with USD is yearly average.

Source: Author's selection from websites, annual reports and OANDA.

Outputs of Econometric Analyses

Output #1

```
      Source |       SS       df       MS              Number of obs =     312
-------------+------------------------------           F(  1,   310) = 1776.90
       Model |  120.121401     1  120.121401           Prob > F      =  0.0000
    Residual |  20.9564659   310  .067601503           R-squared     =  0.8515
-------------+------------------------------           Adj R-squared =  0.8510
       Total |  141.077867   311  .453626581           Root MSE      =     .26

------------------------------------------------------------------------------
     commTOT |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lnm2 |    1.62709   .0385993    42.15   0.000      1.55114     1.70304
       _cons |  -.4486328   .3264045    -1.37   0.170    -1.090881    .1936157
------------------------------------------------------------------------------

Durbin-Watson d-statistic(  2,   312) =  .1009832

Augmented Dickey-Fuller test for unit root         Number of obs   =       310

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.909            -3.455            -2.878            -2.570
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0020

------------------------------------------------------------------------------
     D.coin1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       coin1 |
         L1. |  -.0707039   .0180856    -3.91   0.000    -.1062914   -.0351165
         LD. |  -.1069497    .055503    -1.93   0.055    -.2161641    .0022646
       _cons |   .0024848    .004561     0.54   0.586      -.00649    .0114596
------------------------------------------------------------------------------
```

Output #2

The Granger Theorem states that if Y and X are cointegrated, the relationship can be written as below and at least one between γ_1 γ_2 *must* be $\neq 0$.

(eq.1) $$\Delta Y_t = a_1\,\Delta Y_{t-1} + b_0\,\Delta X_t + b_1\,\Delta X_{t-1} + \gamma_1\,(Y_{t-1} - X_{t-1})$$

(eq.2) $$\Delta X_t = \mathrm{a}_1\,\Delta X_{t-1} + b_0\,\Delta Y_t + \mathrm{b}_1\,\Delta Y_{t-1} + \gamma_2\,(Y_{t-1} - X_{t-1})$$

γ_1 and γ_2 are the coefficient of the cointegrating equation. At least one of them must be statistically different from zero and with *negative coefficient,* as it shows how a variable, when the distance between the two variables grows, is brought back to the equilibrium and the model is then stable. Those coefficients should then be between 0 and –1. It is the *speed of adjustment* of the dependent variable to the equilibrium. For instance, if it is equal to 0.5 it means a 50% movement back to equilibrium following a shock to the model one period later. If it is equal to 1 then there is full adjustment to the equilibrium the period after. A coefficient higher than 1 would not make much sense.

Source	SS	df	MS		
Model	.177201164	3	.059067055	Number of obs =	310
Residual	1.89063841	306	.006178557	F(3, 306) =	9.56
Total	2.06783957	309	.006692037	Prob > F =	0.0000
				R-squared =	0.0857
				Adj R-squared =	0.0767
				Root MSE =	.0786

D.commTOT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
commTOT						
LD.	-.104876	.0548934	-1.91	0.057	-.2128924	.0031404
lnm2						
D1.	-2.367319	1.075996	-2.20	0.029	-4.484607	-.2500303
coin1						
L1.	-.0812382	.0178908	-4.54	0.000	-.1164428	-.0460336
_cons	.0205437	.006461	3.18	0.002	.0078301	.0332574

Source	SS	df	MS		
Model	.000257564	3	.000085855	Number of obs =	310
Residual	.005211015	306	.000017029	F(3, 306) =	5.04
Total	.005468579	309	.000017698	Prob > F =	0.0020
				R-squared =	0.0471
				Adj R-squared =	0.0378
				Root MSE =	.00413

D.lnm2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnm2						
LD.	.0947919	.0571094	1.66	0.098	-.017585	.2071687
commTOT						
D1.	-.006499	.0029625	-2.19	0.029	-.0123284	-.0006696
coin1						
L1.	-.0026633	.0009751	-2.73	0.007	-.004582	-.0007446
_cons	.0039853	.0003435	11.60	0.000	.0033093	.0046612

Output #3

Source	SS	df	MS		
Model	283.69518	1	283.69518	Number of obs =	312
Residual	37.0456178	310	.119501993	F(1, 310) =	2373.98
Total	320.740798	311	1.03132089	Prob > F =	0.0000
				R-squared =	0.8845
				Adj R-squared =	0.8841
				Root MSE =	.34569

NONcommTOT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnm2	2.500503	.0513203	48.72	0.000	2.399523	2.601483
_cons	-9.729133	.4339758	-22.42	0.000	-10.58304	-8.875222

Augmented Dickey-Fuller test for unit root Number of obs = 308

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.709	-3.455	-2.878	-2.570

MacKinnon approximate p-value for Z(t) = 0.0040

D.coin2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
coin2						
L1.	-.1437611	.0387549	-3.71	0.000	-.220024	-.0674983
LD.	-.2046474	.0607481	-3.37	0.001	-.3241889	-.0851058
L2D.	-.1436072	.0591232	-2.43	0.016	-.2599513	-.0272632
L3D.	-.0945171	.0563819	-1.68	0.095	-.2054667	.0164325
_cons	-.0014365	.0118329	-0.12	0.903	-.0247215	.0218485

Source	SS	df	MS
Model	1.90503788	3	.635012625
Residual	13.4892931	306	.044082657
Total	15.394331	309	.049819841

Number of obs	=	310
F(3, 306)	=	14.41
Prob > F	=	0.0000
R-squared	=	0.1237
Adj R-squared	=	0.1152
Root MSE	=	.20996

D.NONcommTOT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
NONcommTOT						
LD.	-.1301126	.0564883	-2.30	0.022	-.2412674	-.0189579
lnm2						
D1.	-2.868	2.843853	-1.01	0.314	-8.463982	2.727982
coin2						
L1.	-.1832619	.0365718	-5.01	0.000	-.255226	-.1112978
_cons	.0255268	.0171685	1.49	0.138	-.0082566	.0593101

Source	SS	df	MS
Model	.000110823	3	.000036941
Residual	.005357756	306	.000017509
Total	.005468579	309	.000017698

Number of obs	=	310
F(3, 306)	=	2.11
Prob > F	=	0.0990
R-squared	=	0.0203
Adj R-squared	=	0.0107
Root MSE	=	.00418

D.lnm2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnm2						
LD.	.1317168	.0567432	2.32	0.021	.0200606	.243373
NONcommTOT						
D1.	-.0011387	.0011296	-1.01	0.314	-.0033616	.0010841
coin2						
L1.	.0000999	.0007302	0.14	0.891	-.0013371	.0015368
_cons	.0037679	.0003417	11.03	0.000	.0030955	.0044402

Output #4

Source	SS	df	MS
Model	323.851649	1	323.851649
Residual	110.99847	310	.358059581
Total	434.85012	311	1.3982319

Number of obs	=	312
F(1, 310)	=	904.46
Prob > F	=	0.0000
R-squared	=	0.7447
Adj R-squared	=	0.7439
Root MSE	=	.59838

NONcommLONG	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
commSHORT	1.460438	.048561	30.07	0.000	1.364887	1.555989
_cons	-7.737542	.613394	-12.61	0.000	-8.944485	-6.5306

Augmented Dickey-Fuller test for unit root Number of obs = 309

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-4.012	-3.455	-2.878	-2.570

MacKinnon approximate p-value for Z(t) = 0.0013

D.coin5	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
coin5						
L1.	-.137106	.0341737	-4.01	0.000	-.2043521	-.0698599
LD.	-.1722922	.057707	-2.99	0.003	-.2858464	-.058738
L2D.	-.1623107	.0557445	-2.91	0.004	-.2720032	-.0526182
_cons	-.0039797	.018784	-0.21	0.832	-.0409422	.0329828

Output #5

Source	SS	df	MS
Model	13.4038046	3	4.46793487
Residual	34.153502	306	.111612752
Total	47.5573066	309	.153907141

Number of obs =	310
F(3, 306) =	40.03
Prob > F =	0.0000
R-squared =	0.2818
Adj R-squared =	0.2748
Root MSE =	.33408

D. NONcommLONG	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
NONcommLONG						
LD.	-.1039714	.0501897	-2.07	0.039	-.202732	-.0052108
commSHORT						
D1.	1.753686	.1919461	9.14	0.000	1.375985	2.131387
coin5						
L1.	-.1598455	.0332285	-4.81	0.000	-.2252308	-.0944602
_cons	-.0038412	.0190743	-0.20	0.841	-.0413745	.0336921

Source	SS	df	MS
Model	.729358602	4	.182339651
Residual	2.30139603	305	.007545561
Total	3.03075463	309	.009808267

Number of obs =	310
F(4, 305) =	24.17
Prob > F =	0.0000
R-squared =	0.2407
Adj R-squared =	0.2307
Root MSE =	.08687

D.commSHORT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
commSHORT						
LD.	-.1805889	.0559078	-3.23	0.001	-.2906028	-.0705751
NONcommLONG						
D1.	.120293	.0131884	9.12	0.000	.0943413	.1462448
LD.	.0294207	.0146473	2.01	0.045	.0005981	.0582432
coin5						
L1.	.018442	.0089171	2.07	0.039	.0008952	.0359888
_cons	.0092288	.0049606	1.86	0.064	-.0005325	.0189901

Output #6

```
      Source |       SS       df       MS              Number of obs =     354
-------------+------------------------------           F(  4,   349) =    7.23
       Model |  .008890947     4  .002222737           Prob > F      =  0.0000
    Residual |  .107345758   349  .000307581           R-squared     =  0.0765
-------------+------------------------------           Adj R-squared =  0.0659
       Total |  .116236705   353  .000329282           Root MSE      =  .01754

------------------------------------------------------------------------------
D.           |
lnindexpos~n |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lnindexpos~n |
         LD. |   .0747558   .0530476     1.41   0.160    -.0295773     .179089
        L2D. |   .1405412   .0517441     2.72   0.007     .0387716    .2423107
    LnSp500  |
         LD. |   .1234158    .035819     3.45   0.001     .0529676    .1938639
        L2D. |   .0584193   .0362431     1.61   0.108    -.0128632    .1297017
       _cons |   .0010496   .0009388     1.12   0.264    -.0007967     .002896
------------------------------------------------------------------------------

. test dl1.LnSp500 dl2.LnSp500

 ( 1)  LD.LnSp500 = 0
 ( 2)  L2D.LnSp500 = 0

       F(  2,   349) =    6.80
            Prob > F =    0.0013

. vargranger

   Granger causality Wald tests
  +------------------------------------------------------------------+
  |          Equation           Excluded |   chi2     df Prob > chi2 |
  |--------------------------------------+---------------------------|
  | D_lnindexposition          D.LnSp500 |  13.275     2    0.001    |
  | D_lnindexposition                ALL |  13.275     2    0.001    |
  |--------------------------------------+---------------------------|
  |         D_LnSp500  D.lnindexposition |  1.6166     2    0.446    |
  |         D_LnSp500                ALL |  1.6166     2    0.446    |
  +------------------------------------------------------------------+
```

Output #7

(a) 1992–2011

```
Vector autoregression

Sample:  7 - 1003                                 No. of obs      =       997
Log likelihood =  2707.525                        AIC             = -5.387212
FPE            =  .0000157                        HQIC            = -5.346071
Det(Sigma_ml)  =   .000015                        SBIC            = -5.278983
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_lncomm	11	.037038	0.1535	180.7411	0.0000
D_LnVix	11	.105769	0.0701	75.20163	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_lncomm						
lncomm						
LD.	-.1129993	.0314991	-3.59	0.000	-.1747364	-.0512623
L2D.	-.1438222	.0306422	-4.69	0.000	-.2038799	-.0837645
L3D.	-.1617723	.0305751	-5.29	0.000	-.2216983	-.1018462
L4D.	.2622039	.0307066	8.54	0.000	.2020202	.3223876
L5D.	.0889301	.0316225	2.81	0.005	.0269512	.150909
LnVix						
LD.	-.0023716	.0110359	-0.21	0.830	-.0240016	.0192583
L2D.	-.0075996	.0113232	-0.67	0.502	-.0297928	.0145936
L3D.	.0045817	.0113372	0.40	0.686	-.0176388	.0268022
L4D.	-.0055847	.0113208	-0.49	0.622	-.027773	.0166036
L5D.	-.011337	.0109907	-1.03	0.302	-.0328784	.0102044
_cons	.0013016	.0011713	1.11	0.266	-.0009941	.0035972
D_LnVix						
lncomm						
LD.	-.1922562	.0899523	-2.14	0.033	-.3685595	-.0159528
L2D.	-.0719579	.0875055	-0.82	0.411	-.2434656	.0995498
L3D.	.1414392	.0873137	1.62	0.105	-.0296925	.3125709
L4D.	.1658828	.0876892	1.89	0.059	-.0059848	.3377505
L5D.	.1749648	.0903048	1.94	0.053	-.0020294	.351959
LnVix						
LD.	-.2391162	.0315153	-7.59	0.000	-.3008851	-.1773472
L2D.	-.0514314	.032336	-1.59	0.112	-.1148087	.0119459
L3D.	.0044932	.0323758	0.14	0.890	-.0589622	.0679487
L4D.	-.0426604	.0323289	-1.32	0.187	-.1060238	.0207031
L5D.	-.0600304	.0313864	-1.91	0.056	-.1215465	.0014858
_cons	.0003075	.0033448	0.09	0.927	-.0062483	.0068632

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
D_lncomm	D.LnVix	2.0707	5	0.839
D_lncomm	ALL	2.0707	5	0.839
D_LnVix	D.lncomm	15.761	5	0.008
D_LnVix	ALL	15.761	5	0.008

(b) 1992–2001

```
. var d.lncomm d.LnVix  if tin(1,482), lags(1/4)

Vector autoregression

Sample:  6 - 482                                   No. of obs      =       477
Log likelihood =  1311.126                         AIC             = -5.421912
FPE            =  .0000151                         HQIC            = -5.360078
Det(Sigma_ml)  =   .000014                         SBIC            = -5.264647

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
D_lncomm             9     .038769   0.1857   108.7909   0.0000
D_LnVix              9     .098655   0.0699    35.8424   0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
D_lncomm     |
      lncomm |
         LD. |  -.0884991   .0440011    -2.01   0.044    -.1747397   -.0022585
        L2D. |  -.1952695   .0435023    -4.49   0.000    -.2805325   -.1100065
        L3D. |  -.1747994   .0436336    -4.01   0.000    -.2603197    -.089279
        L4D. |   .2821224   .0441519     6.39   0.000     .1955863    .3686585
       LnVix |
         LD. |   .0087694   .0179168     0.49   0.625    -.0263469    .0438857
        L2D. |   .0179731   .0183518     0.98   0.327    -.0179958     .053942
        L3D. |   .0314366   .0183175     1.72   0.086    -.0044649    .0673382
        L4D. |   .0082307   .0178413     0.46   0.645    -.0267377     .043199
       _cons |   .0010832    .001762     0.61   0.539    -.0023702    .0045366
-------------+----------------------------------------------------------------
D_LnVix      |
      lncomm |
         LD. |  -.1517995   .1119697    -1.36   0.175     -.371256     .067657
        L2D. |  -.1058286   .1107003    -0.96   0.339    -.3227973      .11114
        L3D. |  -.0278712   .1110345    -0.25   0.802    -.2454948    .1897524
        L4D. |   .1415733   .1123532     1.26   0.208     -.078635    .3617816
       LnVix |
         LD. |  -.2223783   .0455929    -4.88   0.000    -.3117388   -.1330179
        L2D. |  -.1299364   .0466998    -2.78   0.005    -.2214663   -.0384064
        L3D. |   -.025036   .0466124    -0.54   0.591    -.1163947    .0663226
        L4D. |  -.0829582   .0454008    -1.83   0.068     -.171942    .0060257
       _cons |   .0008684   .0044837     0.19   0.846    -.0079195    .0096562
------------------------------------------------------------------------------

. vargranger

   Granger causality Wald tests
  +------------------------------------------------------------------+
  |          Equation           Excluded |   chi2     df Prob > chi2 |
  |--------------------------------------+---------------------------|
  |          D_lncomm            D.LnVix |  3.3238     4    0.505    |
  |          D_lncomm                ALL |  3.3238     4    0.505    |
  |--------------------------------------+---------------------------|
  |           D_LnVix           D.lncomm |  5.8246     4    0.213    |
  |           D_LnVix                ALL |  5.8246     4    0.213    |
  +------------------------------------------------------------------+
```

(c) 2002–2011

```
. var d.lncomm d.LnVix  if tin(483,1003), lags(1/3)

Vector autoregression

Sample:  483 - 1003                          No. of obs      =       521
Log likelihood =  1391.743                   AIC             = -5.288842
FPE            =  .0000173                   HQIC            = -5.244047
Det(Sigma_ml)  =  .0000164                   SBIC            = -5.174484

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
D_lncomm             7      .03652   0.0719   40.34853   0.0000
D_LnVix              7     .112477   0.0711   39.88595   0.0000
----------------------------------------------------------------
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_lncomm						
lncomm						
LD.	-.140799	.0427915	-3.29	0.001	-.2246688	-.0569293
L2D.	-.1432191	.0428236	-3.34	0.001	-.2271517	-.0592865
L3D.	-.203528	.0427445	-4.76	0.000	-.2873056	-.1197504
LnVix						
LD.	.0025844	.0141725	0.18	0.855	-.0251931	.0303619
L2D.	-.024066	.0145927	-1.65	0.099	-.0526671	.0045351
L3D.	-.0182942	.0141684	-1.29	0.197	-.0460638	.0094754
_cons	.0022621	.0015938	1.42	0.156	-.0008618	.0053859
D_LnVix						
lncomm						
LD.	-.1692057	.1317911	-1.28	0.199	-.4275115	.0891002
L2D.	-.0946373	.13189	-0.72	0.473	-.3531368	.1638623
L3D.	.2586992	.1316464	1.97	0.049	.000677	.5167214
LnVix						
LD.	-.2403403	.043649	-5.51	0.000	-.3258908	-.1547897
L2D.	.0056658	.0449432	0.13	0.900	-.0824213	.0937529
L3D.	.0284243	.0436365	0.65	0.515	-.0571018	.1139503
_cons	.0000794	.0049087	0.02	0.987	-.0095415	.0097004

```
. vargranger

   Granger causality Wald tests
```

Equation	Excluded	chi2	df	Prob > chi2
D_lncomm	D.LnVix	3.8775	3	0.275
D_lncomm	ALL	3.8775	3	0.275
D_LnVix	D.lncomm	6.8405	3	0.077
D_LnVix	ALL	6.8405	3	0.077

Output #8

(a) 1992–2011

```
. var d.lnnoncomm d.LnVix, lags(1/5)

Vector autoregression

Sample:  7 - 1003                               No. of obs      =       997
Log likelihood =   1560.85                      AIC             = -3.086961
FPE            =  .0001565                      HQIC            = -3.045821
Det(Sigma_ml)  =  .0001497                      SBIC            = -2.978732

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
D_lnnoncomm          11     .116564   0.0421   43.80507   0.0000
D_LnVix              11     .106207   0.0624   66.3698    0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
D_lnnoncomm  |
   lnnoncomm |
         LD. |  -.0652446   .0314777    -2.07   0.038    -.1269398   -.0035495
        L2D. |  -.1047228   .0314907    -3.33   0.001    -.1664435   -.0430021
        L3D. |  -.1264154   .0313891    -4.03   0.000    -.1879369   -.0648938
        L4D. |  -.0013663   .0314136    -0.04   0.965    -.0629359    .0602033
        L5D. |  -.1139606   .0314052    -3.63   0.000    -.1755135   -.0524076
       LnVix |
         LD. |  -.0215933   .0346597    -0.62   0.533     -.089525    .0463385
        L2D. |  -.0477174    .035526    -1.34   0.179    -.1173471    .0219123
        L3D. |    .034152   .0356368     0.96   0.338    -.0356948    .1039988
        L4D. |  -.0364477   .0356018    -1.02   0.306    -.1062259    .0333304
        L5D. |   .0075483   .0346763     0.22   0.828     -.060416    .0755126
       _cons |   .0036861   .0036782     1.00   0.316    -.0035232    .0108953
-------------+----------------------------------------------------------------
D_LnVix      |
   lnnoncomm |
         LD. |   .0012344    .028681     0.04   0.966    -.0549793    .0574481
        L2D. |  -.0212578   .0286929    -0.74   0.459    -.0774948    .0349792
        L3D. |   .0137114   .0286003     0.48   0.632    -.0423441    .0697669
        L4D. |   .0610489   .0286226     2.13   0.033     .0049496    .1171482
        L5D. |  -.0354506   .0286149    -1.24   0.215    -.0915348    .0206336
       LnVix |
         LD. |  -.2308078   .0315803    -7.31   0.000    -.2927041   -.1689115
        L2D. |  -.0532332   .0323696    -1.64   0.100    -.1166766    .0102101
        L3D. |  -.0021954   .0324706    -0.07   0.946    -.0658365    .0614458
        L4D. |  -.0445685   .0324387    -1.37   0.169    -.1081471    .0190101
        L5D. |  -.0548423   .0315954    -1.74   0.083    -.1167681    .0070836
       _cons |   .0005115   .0033514     0.15   0.879    -.0060573    .0070802
------------------------------------------------------------------------------

. vargranger

   Granger causality Wald tests
  +------------------------------------------------------------------+
  |          Equation           Excluded |   chi2     df Prob > chi2 |
  |--------------------------------------+---------------------------|
  |       D_lnnoncomm            D.LnVix |  5.5129     5    0.357    |
  |       D_lnnoncomm                ALL |  5.5129     5    0.357    |
  |--------------------------------------+---------------------------|
  |           D_LnVix        D.lnnoncomm |  7.4186     5    0.191    |
  |           D_LnVix                ALL |  7.4186     5    0.191    |
  +------------------------------------------------------------------+
```

(b) 1992–2001

```
. var d.lnnoncomm d.LnVix  if tin(1,482), lags(1/5)
```

Vector autoregression

Sample: 7 - 482		No. of obs	= 476
Log likelihood =	672.1054	AIC	= -2.731535
FPE =	.0002232	HQIC	= -2.655834
Det(Sigma_ml) =	.0002035	SBIC	= -2.539016

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_lnnoncomm	11	.148815	0.0708	36.26618	0.0001
D_LnVix	11	.098528	0.0715	36.66724	0.0001

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_lnnoncomm						
lnnoncomm						
LD.	-.1031346	.0454465	-2.27	0.023	-.1922082	-.014061
L2D.	-.1241801	.0455438	-2.73	0.006	-.2134442	-.034916
L3D.	-.14651	.0453798	-3.23	0.001	-.2354528	-.0575672
L4D.	-.0293285	.0454118	-0.65	0.518	-.118334	.059677
L5D.	-.1531535	.045073	-3.40	0.001	-.2414949	-.0648121
LnVix						
LD.	-.1057108	.0690312	-1.53	0.126	-.2410095	.029588
L2D.	-.1249353	.0705038	-1.77	0.076	-.2631202	.0132496
L3D.	.0700921	.0713811	0.98	0.326	-.0698123	.2099965
L4D.	-.0871633	.0707665	-1.23	0.218	-.225863	.0515364
L5D.	-.0124708	.0692811	-0.18	0.857	-.1482592	.1233176
_cons	.0032843	.0067492	0.49	0.627	-.0099439	.0165126
D_LnVix						
lnnoncomm						
LD.	-.0143855	.0300896	-0.48	0.633	-.07336	.044589
L2D.	-.0193504	.0301539	-0.64	0.521	-.0784511	.0397502
L3D.	-.0240012	.0300454	-0.80	0.424	-.0828891	.0348867
L4D.	.039312	.0300666	1.31	0.191	-.0196174	.0982414
L5D.	-.0375761	.0298422	-1.26	0.208	-.0960658	.0209136
LnVix						
LD.	-.2172982	.0457047	-4.75	0.000	-.3068778	-.1277187
L2D.	-.1430859	.0466797	-3.07	0.002	-.2345763	-.0515954
L3D.	-.0495856	.0472605	-1.05	0.294	-.1422145	.0430433
L4D.	-.107666	.0468536	-2.30	0.022	-.1994973	-.0158347
L5D.	-.0503137	.0458701	-1.10	0.273	-.1402175	.0395901
_cons	.0013162	.0044686	0.29	0.768	-.007442	.0100745

```
. vargranger
```

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
D_lnnoncomm	D.LnVix	8.9319	5	0.112
D_lnnoncomm	ALL	8.9319	5	0.112
D_LnVix	D.lnnoncomm	5.0184	5	0.414
D_LnVix	ALL	5.0184	5	0.414

(c) 2002–2011

```
Vector autoregression

Sample:  483 - 1003                          No. of obs      =       521
Log likelihood =  1020.311                   AIC             = -3.862999
FPE            =   .000072                   HQIC            = -3.818205
Det(Sigma_ml)  =  .0000682                   SBIC            = -3.748641
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_lnnoncomm	7	.074417	0.0194	10.30241	0.1125
D_LnVix	7	.112564	0.0697	39.0216	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_lnnoncomm						
lnnoncomm						
LD.	.0409936	.0436154	0.94	0.347	-.044491	.1264782
L2D.	-.0724849	.043578	-1.66	0.096	-.1578961	.0129264
L3D.	-.0846017	.0436194	-1.94	0.052	-.1700941	.0008908
LnVix						
LD.	.0347707	.0288414	1.21	0.228	-.0217574	.0912988
L2D.	-.0152794	.0297253	-0.51	0.607	-.0735399	.0429812
L3D.	.0000848	.0288939	0.00	0.998	-.0565463	.0567158
_cons	.0034873	.0032461	1.07	0.283	-.002875	.0098495
D_LnVix						
lnnoncomm						
LD.	.041004	.0659733	0.62	0.534	-.0883013	.1703093
L2D.	-.0901239	.0659167	-1.37	0.172	-.2193183	.0390705
L3D.	.1359666	.0659793	2.06	0.039	.0066495	.2652838
LnVix						
LD.	-.2379383	.0436259	-5.45	0.000	-.3234436	-.152433
L2D.	-.0029362	.044963	-0.07	0.948	-.091062	.0851896
L3D.	.0339411	.0437054	0.78	0.437	-.0517198	.1196021
_cons	-.0002015	.0049101	-0.04	0.967	-.0098251	.0094221

```
. vargranger

   Granger causality Wald tests
```

Equation	Excluded	chi2	df	Prob > chi2
D_lnnoncomm	D.LnVix	2.1708	3	0.538
D_lnnoncomm	ALL	2.1708	3	0.538
D_LnVix	D.lnnoncomm	6.0271	3	0.110
D_LnVix	ALL	6.0271	3	0.110

Output #9

(a) 1992–2011

```
Vector autoregression

Sample:  7 - 1003                                    No. of obs      =       997
Log likelihood =  1125.873                           AIC             = -2.214389
FPE            =  .0003744                           HQIC            = -2.173248
Det(Sigma_ml)  =  .0003583                           SBIC            =  -2.10616

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
D_lnnocomlong        11     .18056   0.0286   29.33622   0.0011
D_LnVix              11    .106096   0.0644   68.59819   0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
D_lnnocoml~g |
 lnnocomlong |
         LD. |   .0639396   .0314079     2.04   0.042     .0023813    .1254979
        L2D. |  -.0078661   .0314628    -0.25   0.803     -.069532    .0537999
        L3D. |  -.1167583   .0302406    -3.86   0.000    -.1760289   -.0574878
        L4D. |  -.0120244   .0303113    -0.40   0.692    -.0714336    .0473847
        L5D. |  -.0232346    .030249    -0.77   0.442    -.0825215    .0360523
       LnVix |
         LD. |  -.0308078   .0537867    -0.57   0.567    -.1362279    .0746123
        L2D. |  -.1252399   .0550294    -2.28   0.023    -.2330955   -.0173842
        L3D. |   .0172261   .0553005     0.31   0.755    -.0911609     .125613
        L4D. |  -.0575989    .055205    -1.04   0.297    -.1657988     .050601
        L5D. |    .021636   .0537757     0.40   0.687    -.0837625    .1270344
       _cons |   .0037165   .0056929     0.65   0.514    -.0074414    .0148744
-------------+----------------------------------------------------------------
D_LnVix      |
 lnnocomlong |
         LD. |   .0184123   .0184551     1.00   0.318     -.017759    .0545836
        L2D. |  -.0140857   .0184874    -0.76   0.446    -.0503202    .0221489
        L3D. |  -.0010107   .0177692    -0.06   0.955    -.0358377    .0338164
        L4D. |   .0517498   .0178108     2.91   0.004     .0168414    .0866583
        L5D. |  -.0045648   .0177741    -0.26   0.797    -.0394015    .0302718
       LnVix |
         LD. |   -.230547   .0316048    -7.29   0.000    -.2924912   -.1686028
        L2D. |  -.0546619    .032335    -1.69   0.091    -.1180373    .0087135
        L3D. |  -.0019844   .0324943    -0.06   0.951     -.065672    .0617032
        L4D. |  -.0440966   .0324382    -1.36   0.174    -.1076742    .0194811
        L5D. |  -.0554288   .0315983    -1.75   0.079    -.1173603    .0065027
       _cons |   .0004232   .0033451     0.13   0.899    -.0061332    .0069795
------------------------------------------------------------------------------

. vargranger

   Granger causality Wald tests
  +------------------------------------------------------------------+
  |          Equation           Excluded |   chi2     df Prob > chi2 |
  |--------------------------------------+---------------------------|
  |     D_lnnocomlong            D.LnVix |  7.6402     5    0.177    |
  |     D_lnnocomlong                ALL |  7.6402     5    0.177    |
  |--------------------------------------+---------------------------|
  |           D_LnVix      D.lnnocomlong |  9.5235     5    0.090    |
  |           D_LnVix                ALL |  9.5235     5    0.090    |
  +------------------------------------------------------------------+
```

(b) 1992–2001

```
Vector autoregression

Sample:  7 - 483                                   No. of obs      =       477
Log likelihood =  456.2837                         AIC             = -1.820896
FPE            =  .0005549                         HQIC            = -1.745322
Det(Sigma_ml)  =   .000506                         SBIC            = -1.628684
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_lnnocomlong	11	.235164	0.0397	19.69592	0.0323
D_LnVix	11	.098069	0.0782	40.48869	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
D_lnnocoml~g						
lnnocomlong						
LD.	.0240137	.0453438	0.53	0.596	-.0648585	.1128858
L2D.	-.017854	.0452997	-0.39	0.693	-.1066398	.0709318
L3D.	-.1290661	.0430892	-3.00	0.003	-.2135194	-.0446128
L4D.	-.0300629	.0431996	-0.70	0.486	-.1147326	.0546069
L5D.	-.0403679	.0432763	-0.93	0.351	-.1251878	.044452
LnVix						
LD.	-.1117488	.1093117	-1.02	0.307	-.3259957	.1024982
L2D.	-.2388437	.1108066	-2.16	0.031	-.4560206	-.0216667
L3D.	.1040774	.1122517	0.93	0.354	-.115932	.3240867
L4D.	-.0969172	.1112314	-0.87	0.384	-.3149267	.1210922
L5D.	.0256494	.1090738	0.24	0.814	-.1881313	.2394302
_cons	.0007539	.0106453	0.07	0.944	-.0201105	.0216184
D_LnVix						
lnnocomlong						
LD.	.0146031	.0189095	0.77	0.440	-.0224589	.051665
L2D.	-.0117164	.0188911	-0.62	0.535	-.0487424	.0253095
L3D.	-.0215225	.0179693	-1.20	0.231	-.0567417	.0136967
L4D.	.0455337	.0180153	2.53	0.011	.0102243	.0808431
L5D.	-.0028873	.0180473	-0.16	0.873	-.0382594	.0324847
LnVix						
LD.	-.2117214	.0455857	-4.64	0.000	-.3010678	-.122375
L2D.	-.1361711	.0462092	-2.95	0.003	-.2267393	-.0456028
L3D.	-.0459442	.0468118	-0.98	0.326	-.1376936	.0458053
L4D.	-.1089294	.0463863	-2.35	0.019	-.1998449	-.0180139
L5D.	-.0495701	.0454865	-1.09	0.276	-.1387221	.0395819
_cons	.0011988	.0044394	0.27	0.787	-.0075022	.0098998

```
. vargranger
```

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
D_lnnocomlong	D.LnVix	8.3867	5	0.136
D_lnnocomlong	ALL	8.3867	5	0.136
D_LnVix	D.lnnocomlong	8.5082	5	0.130
D_LnVix	ALL	8.5082	5	0.130

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```
. var d.lnnocomlong d.LnVix  if tin(483,1003), lags(1/3)

Vector autoregression

Sample:  483 - 1003                          No. of obs      =       521
Log likelihood =  833.8593                   AIC             = -3.147252
FPE            =  .0001473                   HQIC            = -3.102458
Det(Sigma_ml)  =  .0001396                   SBIC            = -3.032894

Equation           Parms      RMSE     R-sq      chi2     P>chi2
----------------------------------------------------------------
D_lnnocomlong        7      .106709   0.0650   36.19711   0.0000
D_LnVix              7      .112365   0.0730   41.00625   0.0000
----------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
D_lnnocoml~g |
 lnnocomlong |
         LD. |   .2348404   .0437394     5.37   0.000     .1491127    .3205681
        L2D. |  -.0183554   .0449387    -0.41   0.683    -.1064336    .0697228
        L3D. |  -.0746152   .0436831    -1.71   0.088    -.1602326    .0110022
       LnVix |
         LD. |    .041696   .0413828     1.01   0.314    -.0394129    .1228049
        L2D. |  -.0601805   .0426032    -1.41   0.158    -.1436813    .0233202
        L3D. |   -.037147   .0414971    -0.90   0.371    -.1184799    .0441859
       _cons |   .0052598   .0046603     1.13   0.259    -.0038744    .0143939
-------------+----------------------------------------------------------------
D_LnVix      |
 lnnocomlong |
         LD. |   .0335107   .0460577     0.73   0.467    -.0567608    .1237821
        L2D. |  -.0678971   .0473205    -1.43   0.151    -.1606436    .0248494
        L3D. |   .1216999   .0459984     2.65   0.008     .0315446    .2118551
       LnVix |
         LD. |  -.2366194   .0435762    -5.43   0.000    -.3220272   -.1512116
        L2D. |  -.0076323   .0448613    -0.17   0.865    -.0955588    .0802941
        L3D. |   .0405226   .0436966     0.93   0.354    -.0451211    .1261662
       _cons |  -.0004674   .0049074    -0.10   0.924    -.0100857    .0091508
------------------------------------------------------------------------------

. vargranger

   Granger causality Wald tests
  +------------------------------------------------------------------+
  |          Equation           Excluded |   chi2     df Prob > chi2 |
  |--------------------------------------+---------------------------|
  |     D_lnnocomlong            D.LnVix |  4.1631     3    0.244    |
  |     D_lnnocomlong                ALL |  4.1631     3    0.244    |
  |--------------------------------------+---------------------------|
  |           D_LnVix      D.lnnocomlong |  7.8948     3    0.048    |
  |           D_LnVix                ALL |  7.8948     3    0.048    |
  +------------------------------------------------------------------+
```